EARLE GRAY

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PETROLEUM LEGACY:

The birth, evolution, and challenges of a global industry

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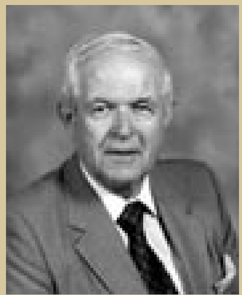
ABOUT THE AUTHOR



Earle Gray was editor of *Oilweek* magazine in Calgary for nearly 20 years. In the 1970s, he was director of public affairs for Canadian Arctic Gas, a consortium of major oil and gas companies that planned and researched a multi-billion dollar gas pipeline from Alaska's Prudhoe Bay and the Mackenzie River delta and Beaufort Sea in the Canadian Arctic. He is a former publisher, editorial consultant, and speech writer. He has written for such publications as the *Canadian Encyclopedia, Maclean's, Financial Post, Toronto Star,* and others. He is the recipient of numerous business writing awards, and a lifetime achievement award from the Petroleum History Society. He is also the author of seven books about the energy industry: *The Great Canadian Oil Patch, The Impact of Oil, The Great Uranium Cartel, Wildcatters, Super Pipe, and Forty Years in the Public Interest: A history of the National Energy Board*, as well as editor of and lead contributor to *Free Trade, Free Canada.*

His second-last book, *The Great Canadian Oil Patch: The Petroleum Era from Birth to Peak*, was published in 2005—a book that McGill University historian Desmond Morton says "rivals Pierre Berton's national dream."

Gray is a native of Medicine Hat, Alberta, but grew up on the West Coast and lived in Alberta and British Columbia for 41 years before moving to Ontario in 1972. He has deep family roots in the two western provinces and in Ontario. His work as a journalist and author has taken him to every province and territory of Canada, from St. John's to Tofino, from the 49th parallel to the northern tip of the Arctic Islands.

PREFACE

Ontario's Petroleum Legacy: The Birth, Evolution, and Challenges of a Global Industry has been a labour of love not only for the author, Earle Gray, but also for all of us who wanted to see the 150th anniversary of Canada's petroleum industry celebrated through new scholarship.

It would not be an overstatement to say that Earle has spent a lifetime studying the rich history of the oil patch—not only the events and people but also the science, technology, and economics. This is a difficult area of research and there are few good industrial historians. Sadly, it would appear that many historians do not view this field as important, although industrial development and economics impact and shape political decision making.

With respect to the life of communities, however, industrial histories are invaluable since they chart the progress of innovation as well as boom-and-bust cycles. Such histories are also important as educational resources because they help present and future generations to understand where we came from and, hopefully, better chart where we are going. I have personal experience of this as the Science and Technology Editor of *The Canadian Encyclopedia* from 1980 to 1984. Unless something is written about, it does not become a part of the narrative of nation building and, therefore, is less real and less important.

Not only does Earle tell a compelling story from the coming in of the first commercial well in Petrolia in 1858, he also places it in an international context. In an age in which "firsts" are so important, he gives many Canadians their rightful place on the international stage.

It is most appropriate that he chose to complete the story with a bridge to the present and future. There is no doubt that the petroleum industry today benefits Canadians and gives us economic power internationally. We also have an opportunity to tackle and address issues of environmental degradation.

How wonderful it would be if this book, and other 150th anniversary activities, were to inspire Canadian leadership at both the government and industry level in resource management and environmental protection and control. The book is a powerful incentive for designation of Oil Springs, Petrolia, Lambton County, Sarnia, and all of the those iconic names of importance to the foundation of this important industry as a UNESCO World Heritage Site.

Like any great enterprise, this work would not have happened without the vision and passion of many. This began with Earle and Robert Bott approaching me as Executive Director of the Heritage Community Foundation to become involved in a range of commemorative activities. A year of telephone and email chats resulted in the creation of a series of proposals for funders. The financial support of Charlie Fairbank, Canadian Petroleum Hall of Fame, and in-kind support of JuneWarren Publishing has made this book possible.

Adriana A. Davies, Ph.D.
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Heritage Community Foundation
and the **Alberta Online Encyclopedia**
www.albertasource.ca

SARNIA REFINERY IN THE 1890s
Credit: *Glenbow Museum Archives*

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AN ENDURING LEGACY This field in Oil Springs, still producing oil today, was awash in crude oil after a "gusher" in 1862. Credit: *Robert Bott*

PROLOGUE

The Oil Heritage Road

The main north-south highway through Enniskillen Township today is County Road 21, now known as the Oil Heritage Road. This modest rural highway, bounded by farms and acreages and woodlots, cuts right through the birthplace of the Petroleum Era in North America. Less than 30 kilometres to the west and northwest one finds the mature offspring of that humble birth—a vast complex of refineries and petrochemical plants along the St. Clair River between Corunna and Sarnia. Ontario's second refinery centre, at Nanticoke, is on the Lake Erie shoreline of the Petroleum Peninsula, 180 kilometres east and a little south of the Sarnia refineries and petrochemical plants.

No matter how we travel the region—by car or bus, on foot or bicycle, or if we fly overhead—petroleum has become so much a part of what we do that it seems invisible. Gasoline, diesel, and jet fuel are all made from crude oil, of course, and so is the synthetic rubber in the tires of motor vehicles, bicycles, and the soles of shoes. Petroleum literally greases the wheels of modern life. The pavement underfoot is either asphalt made from crude oil or cement made using natural gas. Petroleum also provides the molecular building blocks for everything from fabrics to pharmaceuticals, from plastic pipes to shopping bags. Future generations may regard petroleum as "too valuable to burn," but they will most likely still treasure its non-energy uses.

A boggy frontier

In the mid-19th century, most energy came from wood, coal, and the muscles of humans and animals. At that time, Enniskillen Township was considered a frontier area of Canada West*, largely overlooked in the first wave of settlement. It consisted of 86,800 acres (350 square kilometres) of tangled oak, walnut, elm, and black ash forest.

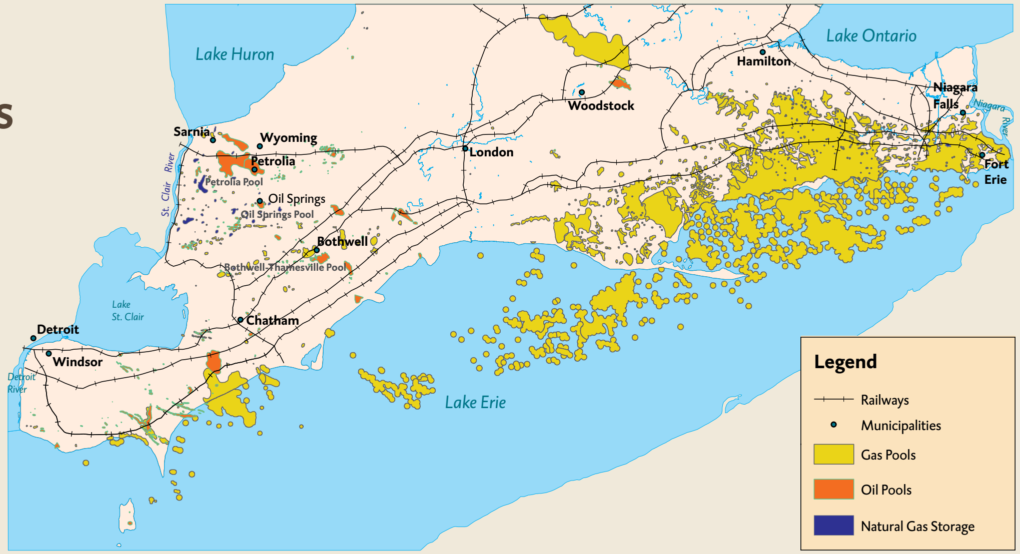
The barrier that faced settlers was water standing on a surface of nearly impervious clay†, up to 24 metres thick, deposited as silt on the bottom of a glacial lake near the end of the last Ice Age, about 18,000 years ago.[1] When it rained, the water could not soak into the ground. The land was so flat that the water had nowhere to run, except at the edges of Bear Creek that cut across the northern part of the township and Black Creek to the south. Water puddled on the surface and turned the heavy loam, known as Brookston clay, into gumbo that mired men, horses, and wagons. The worst part was at the eastern end of the township where the "Great Enniskillen Swamp" was wet and impassable in spring and fall, becoming a hard, dry crust in summer. Because of seasonal standing water, the forest of Enniskillen was relatively thin. The ground was covered by a shin-busting tangle of fallen trees and branches. The first settlers "found it hard to get into Enniskillen, and difficult to get out."[2]

* Present-day Ontario was known as Upper Canada from 1791 until 1841 and then Canada West until 1867.

† Geologists classify most of the near-surface soils in Enniskillen as "alluvium," which is a term for silt, clay, sand, and gravel deposited by running water—in this case water running out of glaciers. Because of the high proportion of fine sediments, early oil explorers called all of the alluvium "clay" and that term is generally used in this text.

Principal Ontario Oil and Gas Fields

Ontario's Petroleum Peninsula



Eliakim Malcom led a dozen men who hacked their way through "brushwood and fallen timber [that] were very thick," to survey Enniskillen township in early September 1832. They camped the first night on Black Creek, then so dry they could find no clean drinking water. Six weeks later, Malcom recorded in his journal: "The ground was so very wet we were obliged to build a bridge of poles to lie upon." The following week, the creek that had only a few inches of stagnant water when they arrived, had "risen to the height of seven feet."[3]

Fourteen years after Malcom completed his survey, there were still only 34 settlers in Enniskillen. These pioneers cultivated fewer than 400 acres, according to an 1847 assessment.

Dim and flickering light

The first settlers of this area lived in a type of dark ages, as did most early Canadian settlers. Rough fireplaces were used for lighting, heating, and cooking. Some evenings there was light from a few tallow candles, but usually settlers needed all the pork and other fat they could collect from their animals for food and making soap. Store-bought candles and lamp oil were too costly and too difficult to haul into the area.

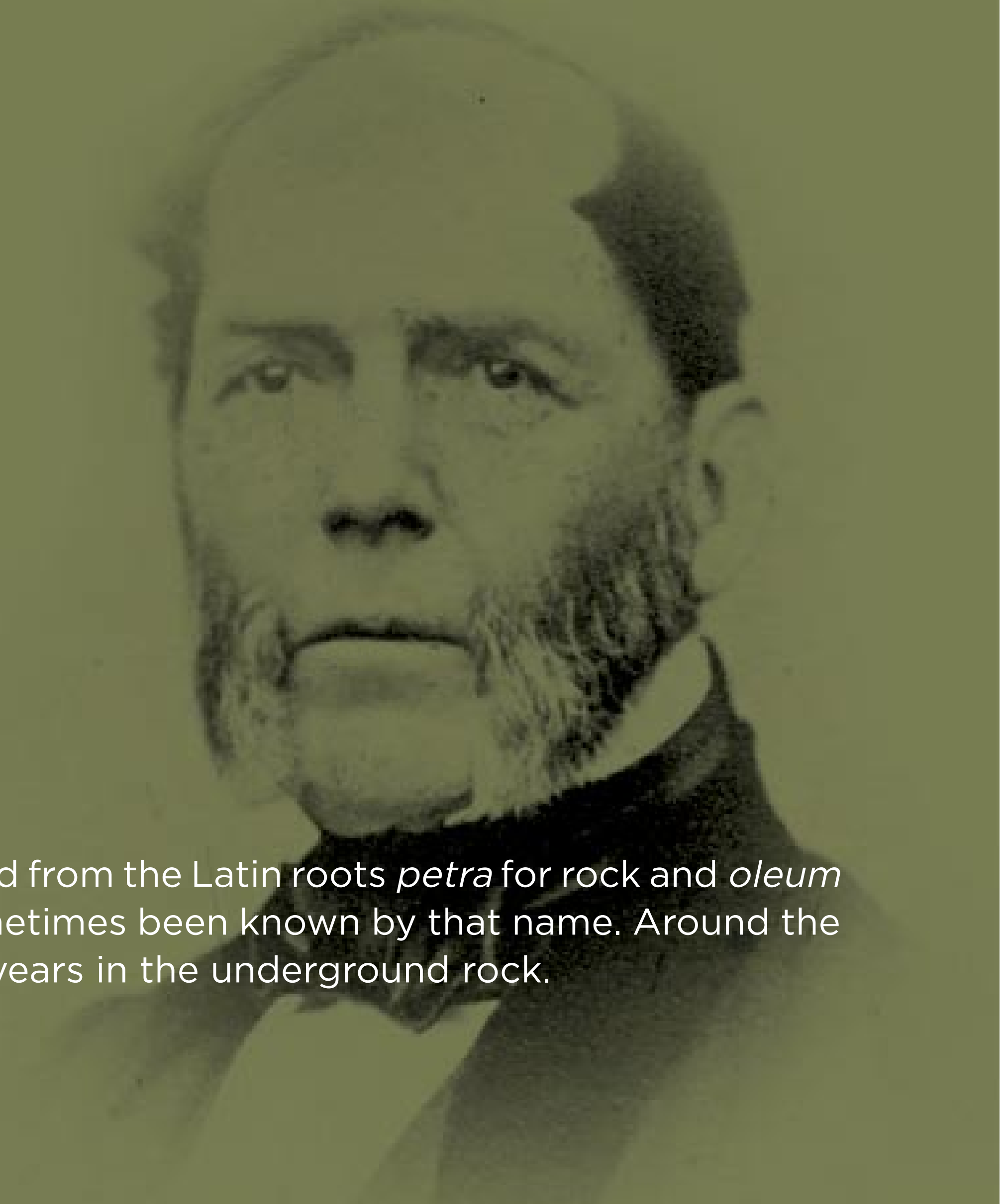
In the towns and villages of that era, light came from both tallow and beeswax candles. The soft tallow candles tended to melt near the hearth or in summer heat, and they were readily devoured by mice and rats. Beeswax candles were better, but more costly. An eclectic array of lamp designs burned lard oil, olive oil, fish oil, or even camphene—an explosive mixture of alcohol and redistilled turpentine. (The turpentine was distilled from pine resin.) The dangerous camphene killed many: 45 in one fire alone that destroyed a theatre in Quebec City, on the site of today's Chateau Frontenac. Many of the lamp oils were smoky and smelly. The best lamps burned whale oil, especially the prized oil from sperm whales. Whale oil had become prohibitively expensive—sperm oil in the United States fetched $1.77 a gallon in 1856, equivalent to about $42 in 2006 U.S. dollars—as sailors hunted whales to the edge of extinction. Gas made from coal was just being introduced for street and building lights: in Montreal in 1836, Toronto in 1841, and Hamilton in 1854.

The fireplace light and the few tallow candles in the Enniskillen cabins at the mid-point of the 19th century were soon to be replaced by a new fuel that would light the lamps of the world. Within a decade, a giant global industry would make its North American start here, the hard task of moving through impassable swamp and the gumbo of Brookston clay would be overcome, and near the banks of Black Creek would rise a new town, more brightly lit than anything else that had ever been seen.

CHAPTER 1

THE LONG EVOLUTION OF AN INDUSTRY

It came from rocks: the word "petroleum" is derived from the Latin roots *petra* for rock and *oleum* for oil. Petroleum is literally "rock oil" and has sometimes been known by that name. Around the world, trillions of barrels of oil lay for millions of years in the underground rock.



ABRAHAM GESNER
Abraham Gesner (1797-1864) developed a process used to distill kerosene from bitumen, coal, shale, and finally from crude oil. A short-lived U.S. coal oil industry based on his work laid the foundation for the petroleum industry.
Credit: *New Brunswick Museum, X10722.*

It has been called oil, bitumen, gum bed, tar, pitch, asphalt, and, in the Bible, slime. But whatever the name or form, people have been using petroleum for many purposes from before recorded history.

Rock of Ages

Oil actually is contained in the pores of rock. Some pores are big enough to stick your finger in; others are as tiny as the spaces between the grains of sand on a beach. Some oil-bearing rocks have been found at the surface or a few metres below; other deposits lie five kilometres or more underground, or under the beds of oceans and lakes. When oil was deeply buried, the weight of the rock above created enormous pressure, and the oil moved upward by capillary action, like sap in a tree, unless it encountered an overlying impervious layer. Reservoirs of oil were created where cap rock prevented the fluid from migrating to the surface. In the reservoirs, the oil was often squeezed between a layer of saltwater below and a layer of natural gas trapped above. But some oil escaped to the surface in areas where there are cracks in the cap rock, or where the overlying rocks are permeable. At the surface, these "oil seeps" polluted wells, springs, and creeks.

Over long periods of time, bacterial action, water flows, and evaporation converted much of the escaped oil into a tar-like substance known as bitumen. The bitumen was often mixed with sand or other materials, or impregnated in surface or near-surface rocks. Some bitumen is found at the surface; other accumulations have been buried in recent times—in geological terms— by deposits from glaciers, oceans, rivers, or wind.

Pumping is often necessary to recover oil from a well dug or drilled into the oil-bearing rock, much as water is pumped from water wells. Sometimes, unless controlled, the oil rushes to the surface and into the air with great force, like an artesian water well: "And the rock poured me out rivers of oil," says the Bible (Job 29:6). The pressure from natural gas, dissolved in the oil or trapped above it, can accelerate the flow.

It has been called oil, bitumen, gum bed, tar, pitch, asphalt, and, in the Bible, slime. But whatever the name or form, people have been using petroleum for many purposes from before recorded history.

First uses

What might be called the world's first petroleum industry developed more than 5,000 years ago in Mesopotamia (now Iraq). Mesopotamians used petroleum to pave the streets of Babylon, and to waterproof their baskets, ships, and mats. They also used it as cement for pottery and mosaics, as medicine, to make paints, to fumigate their buildings, and as a magic potion to ward off evil spirits. Criminals were punished with molten bitumen poured on their heads.

MEDICINE SHOW ELIXIR
In the 19th century, crude oil and bitumen were used as medicine before fuel uses were discovered. This is an exhibit at the Petrolia Discovery
Credit: *Robert Bott*

In the Bible, Noah was commanded by God to "make thee an ark" and "pitch it within and without with pitch" (Genesis 6:14). The "pitch" might have been bitumen, but it might also have been resin similar to the mummia used by the Egyptians to embalm mummies. The basket that hid the baby Moses among the reeds of the Nile would have been waterproofed with bitumen or resin. Roman historian Pliny reported that bitumen was used as a medicine to check bleeding, heal wounds, straighten eyelashes, treat leprous spots and gout, and cure chronic coughs and diarrhea.

Petroleum was distilled at least as early as the first century AD at Alexandria. The resulting naphtha was used in a weapon of war known as Greek Fire. Arab and Mongol armies deployed some form of Greek Fire in grenades and flame throwers. The Shah of Persia is said to have used hollow iron horses filled with burning oil, possibly derived from petroleum, to defeat an Indian army mounted on elephants. Some 20,000 jars of Greek Fire helped feed the flames that destroyed Cairo in 1077. Surface and near-surface deposits of crude oil and bitumen have also been used locally for various purposes for at least a millennium in places such as Burma (now Myanmar) and the Caspian Sea region of Asia.

In the Western Hemisphere, no less than elsewhere, crude oil and bitumen were used for medicine and waterproofing. In the late 18th century, Alexander Mackenzie found the Cree Indians using bitumen from the vast deposit of the Alberta oilsands to caulk their canoes. In Mexico, bitumen was used as a toothpaste and chewing gum.

Spanish explorers in 1526 were the first Europeans to find bitumen in the Western Hemisphere, in Cuba. Drake, Raleigh, De Soto, and other sailors caulked their ships with bitumen from Cuba and other bitumen deposits along the Gulf of Mexico, in Peru, and from Trinidad's famous asphalt lake.

The European distillers

While Greeks and Arabs started distilling petroleum as early as AD 100, Western Europeans first found out about this method a thousand years later from the Arabs who had invaded Spain.[1] In the following centuries, Europeans experimented widely with new methods of distilling and refining or treating new types of petroleum products for which they found new uses.

One of the first European "oil men" was Martin Eele who, with Thomas Hancock, and William Portlock, obtained an English patent in 1694 to produce "pitch, tar and oyle out of a kind of stone." This process involved grinding petroleum-bearing shale and then using hot water to separate the oil from the rock—an early version of the method later used to separate bitumen from Alberta oilsands. Eele's British Pitch Works at Benthall produced tar used for coating the hulls of ships as well as a medicinal oil.

French physician Jean-Théophilus Hoeffel (1704-1781) in 1728 began six years of experiments with distilling a sulphurous crude oil skimmed from the water of a spring in Alsace. Hoeffel produced various oils used as medicine and "extremely inflammable"[2] naphtha, which he is reported to have burned in a lamp. Archibald Cochrane (1749-1831), the ninth Earl of Dundonald, may have been the first to distill a liquid fuel from coal. He burned it in a lamp, but no commercial development followed.

Ozokerite, a mineral wax dipped from shallow pits dug in the Carpathian Mountains of eastern Europe, was burned in the street lights of Krosno, Poland, as early as 1500. It was also used to lubricate wagon wheels, treat leather, and, of course, as a medicine. Between 1810 and 1817, Joseph Hecker and Johann Mitis sought to establish a business selling a lamp fuel that they distilled from Polish ozokerite. They obtained a large order from the Town Council of Prague to light

The 19th century was time of great scientific and technological advance. Clever tradesmen, mechanics and miners, gentleman scientists, entrepreneurs, and academics rushed to extend and apply the growing knowledge of geology, chemistry, physics, and engineering.

the city streets, but their business failed from lack of capital and the difficulty of delivering their product over bad roads to Prague.

From 1830 to 1834, German industrialist and scientist Carl Ludwig von Reichenbach (1788-1869) experimented with the distillation of coal and wood to produce a number of new hydrocarbon compounds, including creosote, paraffin, compounds used in perfumes and antiseptics, and a liquid fuel similar to the types that would later burn in lamps.

While most efforts focused on producing liquid fuel or medicine from crude oil, bitumen, ozokerite, or coal, Scottish engineer and inventor William Murdoch (1754-1839) in 1792 distilled coal at much higher temperatures to produce a volatile gas. A cotton mill in Manchester in 1805 became the first building entirely lit by Murdoch's coal gas*, and for more than a century, coal gas was a major source of light on streets, in factories, and homes. Murdoch even used his coal gas to fuel a portable lantern, according to his friend William Fairbairn. The two faced a long walk over bad roads on a dark night. "Mr. Murdoch," Fairbairn wrote, "went to the gasworks where he filled a bladder which he had with him, and, placing it under his arm like a bagpipe, he discharged through the stem of an old tobacco pipe a stream of gas which enabled us to walk in safety."[3]

Around 1835, French chemist, Alexander Selligue, heated a coarse metamorphic rock, schist impregnated with bitumen, to distill a volatile liquid that was first used to enrich coal gas. In 1838, Selligue patented his oil as a lamp fuel, and within a few years was operating three small refineries in France producing oil used both as lamp fuel and to enrich coal gas.

* Coal gas, also known as town gas or syngas, is a mixture of hydrogen, carbon monoxide, methane, and other volatile hydrocarbons (plus small amounts of non-combustible nitrogen and carbon dioxide). Coal gas was used widely for lighting, cooking, and heating until it was displaced by electricity and natural gas. Some coal gas or "syngas" is still produced in the United States.

Polish pharmacist Jan Józef Ignacy Łukasiewicz (1822-1882) is often cited as the first to distill and refine a lamp fuel from crude oil, rather than from coal or bitumen, although his initial raw material may have been ozokerite. His achievement was announced in 1852. Refining at this time primarily meant treating in various ways the initially distilled product with sulphuric acid and alkalines to remove impurities and reduce objectionable odours.

The 19th century was time of great scientific and technological advance. Clever tradesmen, mechanics and miners, gentleman scientists, entrepreneurs, and academics rushed to extend and apply the growing knowledge of geology, chemistry, physics, and engineering. This knowledge spread rapidly through lectures, correspondence, and publications. It was not surprising that similar innovations often emerged almost simultaneously in Europe and North America†.

A decade before Łukasiewicz' announcement, Nova Scotian Abraham Gesner had begun experiments to produce a similar lamp fuel from bitumen, and later from coal and from a bituminous mineral called albertite. Gesner first demonstrated his product in 1846. Gesner named the product "kerosene‡" (from the Greek word for wax, *keros*). Łukasiewicz said he was inspired in his efforts by Gesner's work. Łukasiewicz also invented a prototype kerosene lamp, demonstrated during an emergency operation in the hospital at Lwow. By 1856, he built the first oil refinery near Jaslo, producing kerosene from crude oil, while others were at work operating,

† In the United States, for example, Pittsburgh industrialist Samuel M. Kier was distilling crude oil from surface oil seeps as early as 1851 or 1852. He relocated the operation from Pittsburgh to Lawrenceville in 1854. His product may have been sold mainly as medicine since it did not appear to have made an impact in the lamp oil market. Kier's small still is in the collection of the Drake Well Museum in Titusville.

‡ Kerosene, also known as coal oil or stove oil (or "paraffin" in Great Britain), is a liquid mixture of hydrocarbon molecules that contain 12 to 15 carbon atoms. It is denser than gasoline but lighter than diesel fuel. During fractional distillation, kerosene condenses between 150°C and 275°C. The most common use of kerosene today is jet fuel for aircraft.

JAMES YOUNG
James Young (1811-1883) followed on the heels of Abraham Gesner in developing a process to distill oil from coal and shale, but obtained a U.S. patent before Gesner. U.S. coal oil refiners were obliged to pay royalties to Young. Young became prosperous while Gesner died impoverished.
CREDIT: *University of Strathclyde, Glasgow.*

building, or planning coal oil refineries to produce kerosene[4] At Rifov, Romania, Theodor Mehedinteanu started another small crude oil refinery in 1856.

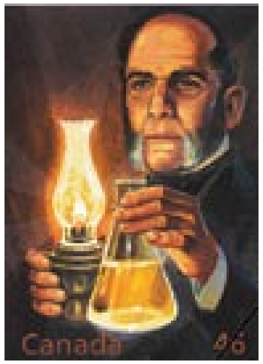
By far the most commercially successful of all European distillers was a Scottish chemist, James Young (1811-1883), who built the first truly commercial, large-scale coal oil works, acquired a fortune, and became a great philanthropist. He was also the nemesis of Abraham Gesner.

Young got into the oil business in 1848, collecting oil that flowed slowly from a coal mine in Derbyshire, England, and selling it as lubricating oil. The supply of oozing oil was soon exhausted, and the following year Young began experimenting with the distillation of coal and oil shale as an alternate supply. He obtained a British patent for his distilling and refining process in 1850 and the next year opened his first oil plant in Scotland, using oily "bog coal" (torbanite*) from a nearby mine. His plant produced lubricating oil, a solvent used with rubber to make a waterproofing compound, and ammonium sulphate fertilizer—but no lamp fuel for at least five years.

Others soon began producing lubricating oils and solvents from coal and shale, and quickly found they were forced to pay royalties to Young, who vigorously enforced his patent rights.

In the United States, Luther Atwood used coal tar, a byproduct from the manufacture of coal gas, to produce a lubricant he called "coup oil," which he patented. A Glasgow firm, George Miller & Company, hired Atwood for technical assistance in building a coup oil plant in Scotland. While working for Miller, Atwood experimented with Young's lubricating oil, re-distilling it to yield a water-white,

* Torbanite, also known as cannel coal or boghead coal, is a type of coal derived from algae, and it is similar in geological age and properties to the albertite found in New Brunswick. Slow distillation of torbanite produces paraffin oil and paraffin wax, which can be used for heating, lighting, and industrial purposes.



ABRAHAM GESNER
Abraham Gesner (1797-1864) developed a process used to distill kerosene from bitumen, coal, shale, and finally from crude oil. A short-lived U.S. coal oil industry based on his work laid the foundation for the petroleum industry. Credit: *New Brunswick Museum, X10722.*

"The progress of discovery in this case, as in others, has been slow and gradual. It has been carried on by the labours, not of one mind, but of many, so as to render it difficult to discover to whom the greatest credit is due."

–**ABRAHAM GESNER**, 1861, on the development of coal oil refining[6]

bright-burning lamp fuel. On a visit to Miller's office, Young saw his re-distilled oil burning in a lamp. That was when he decided that, in addition to lubricating oil, solvent, and fertilizer, he would get into the business of producing and marketing lamp oil.[5] That was in 1856. In New York, the first North American coal oil plant was already producing kerosene for lamp fuel, based on the work of that Nova Scotian man-of-all-trades, Abraham Gesner.

Gesner and the coal refineries

Abraham Gesner, in Nova Scotia and New York, and James Young, in Scotland, were the towering figures, and antagonists, in the large-scale commercial development of kerosene refining. Gesner was first in the field and died impoverished. Young followed, and he died wealthy.

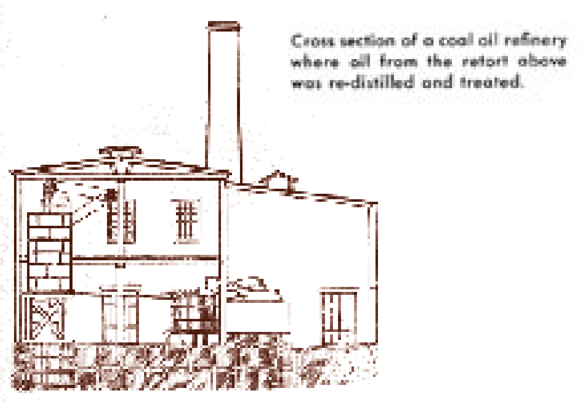
Gesner's long and winding road began with a youthful adventure in horse trading and ultimately led to the study of *Coal, Petroleum and Other Distilled Oils*, as he titled his landmark 1861 treatise that would become a bible for oil refiners for nearly half of a century.

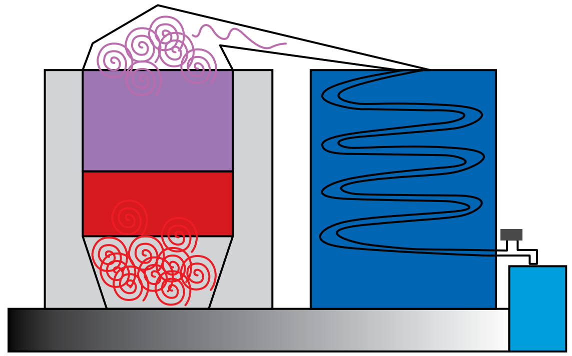
The story begins in 1816, the "year without summer." The Mount Tambora volcano in Indonesia exploded the year before with a blast that was heard 1,900 kilometres away, killing an estimated 71,000 people, spewing heavy ash into the atmosphere, cooling temperatures, and causing the Northern Hemisphere's worst famine of the 19th century. Worst hit were northern Europe, northeastern United States, and eastern Canada. Crop failures in Europe caused some 200,000 deaths. Quebec City was buried under almost a foot of snow at the end of June. Ice was seen on rivers and lakes in July and August as far south as Pennsylvania. Nova Scotians knew hunger. With lack of feed, their horses were slated for slaughter.

To rescue the horses and provide some money for the Gesner family and neighbouring farmers around Chipman's Corner on the Bay of Fundy, 19-year-old Abraham launched an ill-fated career as a horse trader. His plan was to ship the hungry horses to be sold in the West Indies. Gesner sailed with the horses as a deckhand. He returned home in mid-winter with no money, but he also brought a cargo of rocks, minerals, shells, curios, and a pile of bitumen from the "pitch lake" in Trinidad that had caulked the ships of Sir Walter Raleigh and others. Two succeeding voyages were greater disasters—both ended in shipwrecks.

Following the footsteps of his father, Gesner turned to farming, married the daughter of a prominent local doctor, and fathered 11 children. Insatiably fascinated by natural history and all things scientific, he perhaps spent as much time studying "scientific farming" as time behind the plough. He fell into debt and was in danger of imprisonment. He was rescued by his father-in-law who sent him off to London to study medicine. He returned as a doctor who had also studied geology and chemistry in London.

Back in British America, his career as a doctor was soon overshadowed by his many other roles: New Brunswick's first provincial geologist; author of more than 20 books, papers, and reports; a popular lecturer; founder of what became New Brunswick's provincial museum; and inventor of one of the first electric motors, a wood preservative, a machine for insulating electric wires, and a process to pave highways with bitumen.





COAL OIL REFINERY AND STILL DIAGRAM. The diagram of the coal oil refinery is based on G.A. Purdy's *Petroleum: Prehistoric to Petrochemicals*. A retort with a gooseneck spout can be seen in the refinery diagram. The still diagram shows such a retort in more detail.

Finally, Gesner turned his attention to distilling the bitumen he had brought from Trinidad, the first of some 2,000 distillation and refining experiments he conducted. He began his experiments seven years before James Young. The Trinidad bitumen gave only a low yield of smoky, smelly oil. Gesner then turned to a thick bed of solid hydrocarbon that he had found in Albert County in his geological survey of New Brunswick. He called the deposit albertite*.

Five years after his first experiments, Gesner publicly demonstrated his oils distilled from albertite at Charlottetown, Prince Edward Island, on June 19, 1846. He named the oils kerosene A, B, and C. Kerosene A was the most volatile, essentially gasoline; Gesner thought it might be used in a pressurized gasoline lamp, as it later was. Kerosene B, he suggested, could be blended with the other two. Kerosene C was destined to become the standard fuel for coal oil lamps, and today's jet aircraft.

Gesner, along with others, was focused not on lamps fuelled with a liquid, but on gas light. He envisioned kerosene being converted to a gas that would give a superior, brighter light than the coal gas then lighting so many streets and buildings in Europe and North America. Those who witnessed his demonstration at Charlottetown that day, and others that followed in the Maritime Colonies and in New York City, saw kerosene heated in a retort producing gas that bubbled through water to remove impurities and through a regulator to the burner tip or lamp.

Gesner was still ahead of his Scottish rival James Young, who would not start his distillation experiments for another two years. By that time, Gesner's work was fairly well known, as witness the Polish chemist who used Gesner's process to produce kerosene from crude oil. But in commercial application of his work, Gesner would fall well behind Young, with disastrous results for his always precarious personal finances.

There were two problems: one was that Gesner, in mid-1854, was late in securing a U.S. patent for his distilling and refining processes. Young secured his British patent in 1850 and his U.S. patent in 1852. The second problem was that Young commercialized his processes immediately, while Gesner faced delays and difficulties due to his lack of sufficient funds to develop and market his inventions.

Gesner organized a company he hoped would provide Halifax with kerosene gas distilled from albertite, but the city fathers awarded a franchise to a competitor. Undaunted, Gesner took out a lease to mine the albertite bitumen. Another group, somehow exempt from giving the customary public notice, obtained a coal lease for the same deposit. In a heated court case that followed, the jury decided that albertite was really coal—which it clearly was not—and Gesner lost the right to mine the deposit he had discovered.

In search of backers with money, Gesner then moved to New York, where he had earlier demonstrated his kerosene and garnered substantial publicity. Here he found help from a 28-year-old promoter with the appropriate name of Horatio Eagle who issued an eight-page circular entitled, *Project for the Formation of a Company to Work the Combined Patent Rights of Dr. Abraham Gesner, Nova Scotia, and the Right Hon. the Earl of Dundonald of Middlesex, England*. The circular offered for sale $100,000 in shares of a new company at first called the Asphalt Mining and Kerosene Company, later the North American Kerosene Company. The circular listed a wide range of possible uses for the kerosene oils: waterproofing, paving, insulating underground telegraph wires, making paints and varnishes, as solvents, "burning fluids," and to produce gas "for lighting manufactory."

* Albertite is an unusual solid hydrocarbon, resulting from degradation of the kerogen (partially formed crude oil) seeping out of shales. It shares some characteristics with coal, oilsands bitumen, and "bog coal" or torbanite, but is distinct in its origin and properties.

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For Gesner, there were two flies in the ointment. Having assigned the patents to the company, Gesner was merely an employee, the chief chemist, hired "at a modest salary," as the circular pointed out. A greater problem was that his first patents had been issued by the State of New York and were subsidiary to Young's 1852 U.S. federal patent.

Construction of the Kerosene Company's New York coal oil plant—the first in North America and the world's largest—began in 1854. By early 1856, the firm was in the market selling kerosene for lamp fuel. It was the same year that James Young made his first shipment of lamp fuel. Within four years, some 70 coal oil plants had sprung up in the eastern United States. The North American Kerosene Company's plant was still the largest. As described by the *New York Commercial Advertiser* in 1859, it was a plant that cost $1.25 million, employed 200 men, used 30,000 tons of coal per year, and was able to turn out up to 5,000 gallons of kerosene per day. The latter figure, equivalent to 119 barrels per day, seems inflated, unless the plant operated fewer than 250 days per year. It is unlikely that refining a ton of coal would yield more than a barrel of kerosene.

The plant eventually fell into the hands of one of John D. Rockefeller's Standard Oil companies and continued to operate until 1951 when it was sold for scrap.

Gesner, too, seemed tossed on the scrap heap. Young brought suit against the North American Kerosene Company for patent infringement and won, forcing payment of royalties, as he did with many other coal oil producers. With that, little more than a year after the plant started producing, Gesner was fired. His replacement as company chemist was Luther Atwood, who was also chief chemist for a rival coal oil producer in Boston and the man who had unwittingly inspired James Young to add lamp fuel to the products of his Scottish shale oil works. Gesner

GESNER MONUMENT
The body of Abraham Gesner, widely credited as the father of the North American petroleum industry, lay in an unmarked grave in Halifax for 39 years, until this monument was erected by Imperial Oil in 1933.
Credit: *Imperial Oil Collection, Glenbow Museum, ip=1a-67*

By the late 1850s, it was widely recognized that bright-burning kerosene could be made from liquid crude oil at a fraction of the cost of producing it from bitumen or coal. Now, all that was needed for the petroleum industry to emerge was a significant supply of crude oil.

remained in New York for a few years, practising medicine and writing his famous treatise on coal and petroleum refining. He returned to his native Nova Scotia to accept a position as professor of natural history in late 1863, but died five months later, on April 29, 1864.

The legacy that Gesner left was his key role in creating conditions for a petroleum industry that, one historian has said, was just waiting to happen.[7] Though the existence of petroleum and the basics of distilling it had been known for millennia, it was the coal oil industry that made the Petroleum Era inevitable. The coal oil industry created the product, the technology, the refineries, the distribution, and the sales network. As society urbanized and industrialized and became more literate, the need for light was almost insatiable—on city streets, in factories, shops and homes, railways, ships, and lighthouses. By the late 1850s, it was widely recognized that bright-burning kerosene could be made from liquid crude oil at a fraction of the cost of producing it from bitumen or coal. Now, all that was needed for the petroleum industry to emerge was a significant supply of crude oil. A carriage maker and mining promoter in Lambton County, Canada West, would be the first in North America to provide that supply. ■

Imperial and metric measurement

In 1979, Canada, including the Canadian petroleum industry, adopted the metric system of measurement—officially known as the Système International d'Unités or SI. Until then, Canada used the Imperial system, which is similar but not identical to the system still used in the United States.

To avoid the awkwardness of translating the many historical measurements, and to preserve the original context, we have used Imperial for all units in chapters 2 through 5. It should also be noted that some Imperial units such as barrels, cubic feet, and acres remain in common usage in the Canadian petroleum industry, although government authorities generally use metric.

Some common Imperial units (and metric equivalents) are: inch (25.4 millimetres), foot (30.48 centimetres), yard (91.4 centimetres), mile (1.61 kilometres), acre (0.4 hectares), pound (454 grams), barrel (159 litres), Imperial gallon (4.55 litres), and cubic foot (0.028 cubic metres).

CHAPTER 2

ENNISKILLEN'S OIL PIONEERS:

FIRST DISCOVERIES AND EARLY DEVELOPMENT

By the 1850s in the towns of Canada West, one could find offered for sale a bewildering array of oils to fuel lamps, grease railway locomotives, wagons, and machinery, tan leather, and make soap. In Toronto's *Globe* on January 10, 1857, F.P. Pearse of Buffalo advertised "sperm, whale, lard, linseed & tanning oil" as well as "Pearse's improved machinery and burning oil." The following year, Hubert Pomeroy advertised "Mason's sperm oil... the cheapest and best lubricant known," also good for "burning purposes." Oils distilled from coal were also advertised. On October 10, 1858, Ross Bryson advertised "pure Albertine coal and lunar oils," as well as "Young's celebrated coal oil lamps." In 1859, coal oil, lard oil, palm oil, and wool oil were offered "for sale at lowest rates" by Lyman Brothers. Soon there would be a new, local source to replace all of those products.

In 1850, the only commercial use of crude oil in North America was as medicine, and the small amounts required were quite easily obtained from surface seepages.

THOMAS STERRY HUNT
Thomas Sterry Hunt, chemist and geologist with the Geological Survey of Canada. His report on commercial possibilities of a bitumen deposit in Enniskillen Township, Canada West, attracted the attention of Charles Nelson Tripp, who tried to establish a business turning the bitumen into asphalt for paving.
Credit: *The Canadian Album Volume 4 1891-1896*

A cheaper source of light

In the span of four or five years, the new coal oils had begun to dominate North American markets for lamp fuel. Yet their fate was already sealed by a pair of visionary entrepreneurs who would be the first to develop in North America a different raw material, one from which such oils could be made so cheaply that they would drive all others off the market. That supply came with the discovery in Canada West of North America's first commercial oil well, and creation of the first integrated crude oil production, refining, and marketing operation. This was the achievement of Charles Nelson Tripp and James Miller Williams.

Tripp could almost be said to have found North America's first oilfield, and he explored Canada's first three—Oil Springs, Petrolia, and Bothwell—years before commercial oil production began at these fields. He certainly dug at Oil Springs, as early as 1850. He attempted to pound down a well at Bothwell five years before the first producing oil well there. He also acquired property at what later became the Petrolia field and might have dug there 10 or 11 years before the first oil well there.

Tripp might even have found crude oil and spurned it. In 1850, the only commercial use of crude oil in North America was as medicine, and the small amounts required were quite easily obtained from surface seepages. So how much value would there seem to be in a mixture of oil and water from depths of 5 yards or 15 yards in a wilderness area with daunting access and transportation difficulties?

Tripp, in any event, was not focused on crude oil; his initial interest lay in mining bitumen to produce asphalt* for paving streets and sealing the hulls of ships, and possibly for use in manufacturing gas to light streets and buildings. To launch his effort to mine a pair of bitumen deposits—known locally as "gum beds"—on Black Creek in Enniskillen Township, Tripp registered the world's first incorporated oil company, in 1854. When that failed, James Miller Williams, a Hamilton carriage maker, set out to distill the bitumen for lamp fuel and lubricating oil, establishing in Enniskillen Township Canada's first petroleum-based refinery. Then, digging through the gum bed, Williams found liquid crude oil itself.

Discovering the resource

Thomas Sterry Hunt, the brilliant chemist and geologist with the Geological Survey of Canada (GSC), gets the credit for Tripp's focus on bitumen. It was Hunt who in 1850 drew attention to the commercial possibilities of the gum beds on Black Creek. Governor General Charles Murray Cathcart had sent a sample of the bitumen to the GSC for analysis, and the member for Kent in the legislature of Canada had followed this with another 100-pound sample. Hunt reported the samples to contain 78 per cent to 81 per cent "combustible volatile material." In the GSC's annual report for 1849-1850, Hunt wrote:

> The use of this material in England and the Continent to build roads, to pave the bottom of ships, to manufacture gas for lighting, for which it is eminently suited, is sufficient to attract considerable importance to the deposits that are in this country.

That report attracted the attention of Tripp, who would spend the rest of his life scouring geological reports and pursuing a vision of mining wealth.

Charles Tripp, and his younger brother Henry, had come from Schenectady, New York, to find their fortunes in Canada. Charles' career would display the classic

* Asphalt is a form of petroleum that is solid or semi-solid at room temperature, but becomes pourable when heated to about 100° C. Most bitumen contains a high proportion of asphaltenes, the big, carbon-rich molecules that comprise asphalt. In some usages, especially outside North America, the terms bitumen and asphalt are used interchangably.

Two years after Hunt pointed to the commercial prospects, Charles Tripp filed a petition to form an oil company and hauled in equipment and erected buildings to boil the Enniskillen bitumen into asphalt.

character of a promoter and wildcat* prospector: resourceful, energetic, a super salesman fired by big ideas, not overly practical, nor devoted to detail. His eyes were more on the forest than the trees. Henry, an itinerant photographer, was more pragmatic, and in Enniskillen, it would be his role to pick up some of the pieces of Charles' shattered dreams.

When the GSC report that featured the economic prospects of the Enniskillen gum beds was published, Charles was 250 miles away, at Bath, near Kingston, where he was foreman of a stove factory. Henry was closer to the gum beds, at Woodstock. Also at Woodstock was Alexander Murray, who combined farming with geological field work for the GSC.

Two years after Hunt pointed to the commercial prospects, Charles Tripp filed a petition to form an oil company and hauled in equipment and erected buildings to boil the Enniskillen bitumen into asphalt. That could only have followed considerable planning, organization, and exploration of the bitumen not later than 1851, or even 1850, within months of Hunt's report. It is Alexander Murray who hinted at the earlier date. The GSC sent Murray to examine the gum beds in the summer and fall of 1851, and his report suggests that the Tripps might have beat him there by a year. In the GSC report for 1851, Murray writes that the deposit covers no more than half an acre. He adds:

> By different trial holes which have been sunk through the deposit, it would appear to have a thickness of over two feet.... The bitumen is underlaid by a very white clay, which I was informed had been bored through in one part for thirty feet. The upper portion of the clay was observed to be more or less penetrated with petroleum, and small black globules of the same were seen scattered through the mass for a depth of four or five feet.

Murray's report of a two-foot, half-acre deposit refers only to the "east gum bed," on the south side of Black Creek; another, larger deposit lay a short distance west.

Murray's report also leaves some maddening questions. The most probable person to have "informed" Murray about the reputed 30-foot hole was Henry Tripp: he and his brother had already been in to examine the site, and perhaps it was they who sunk that hole. That hole was undoubtedly dug—as were all subsequent holes at this site for about another decade; it is inconceivable that the Tripps, or anyone else, would in 1850 have brought drilling equipment into an area so difficult for hauling. Yet a 30-foot dug hole is also difficult to imagine. Some cribbing with logs would probably have been required to prevent a cave-in and the job seems more than a two-man effort. Was the reported depth an error, or perhaps a promoter's exaggeration? Nor is Murray explicit about who was responsible for the "different trial holes which have been sunk." Was it he, with the aid of an assistant, or was it the Tripp brothers the year before? When Murray says he was informed that one part of the deposit had been "bored" through for 30 feet, that suggests other parts had also been dug through.

Despite the puzzle of the 30-foot depth, the evidence suggests that the Tripps were aggressively exploring at least the smaller, east gum bed in 1850.

Possibly the same year he first visited the bitumen deposits on Black Creek, Tripp likely wandered 12 miles north to visit an oil seepage or "oil spring" on Bear Creek. Here he acquired 50 acres (lot 13 in the 11th concession). The land records show him as the registered owner of the property on April 18, 1853, purchased from Luther Dunn for £250. Three years later, Tripp sold 40 acres on the same lot for £1,500. Visiting Oil Springs in 1861, a *Globe* reporter found that there were 13

* A "wildcat" is a petroleum industry term for a well drilled where no oil or gas production exists nearby. People who drill such wells are called "wildcatters."

OIL SEEP
A seep can still be found today, adjacent to the 1858 discovery well in Oil Springs. Credit: *Robert Bott*

There is oral history indicating that a native trading route led to oil seeps in the area and that the oil or bitumen was used as a sealant for containers and canoes.

small, shallow oil wells at Petrolia, and seven more were being dug.[1] The reporter also wrote:

> Upon lot No. 13 in the 11th concession of Enniskillen was a natural oil spring, which led to the discovery of the 'territory' it is upon, the property belonging to Messrs. Adams. Proceeding to dig a well they found that at some remote period others had been there before them, with the same intent. The hole previously made had been filled up, but its dimensions and depth could be traced by the mixture of the soil with shale and gravel, contrary to the natural order of things. In another place, nearer the creek, at a depth of thirty feet, a deer's horn was found in a good state of preservation… In a third place, at a depth of thirty-five feet, a rib was discovered by the miners.

Tripp might have been the earlier digger, but the phrase "at some remote period" indicates the three holes might also have been pre-settlement pit diggings by Aboriginal people. There is oral history indicating that a native trading route led to oil seeps in the area and that the oil or bitumen was used as a sealant for containers and canoes. Near the oil seepage at Titusville, Pennsylvania, carbon dating has confirmed that a number of "mystery holes"—shallow pits lined with wooden cribbing—had been dug by native people sometime between 1550 and 1640. But did native people have the tools to dig as deep as 35 feet at Bear Creek? Or were these holes dug by Tripp, on the property he acquired?

In his application to incorporate an oil company, Tripp claimed to be the owner of an oil spring in the Western District, the administrative precursor to Kent, Essex, and Lambton Counties. Land title records show that Tripp on April 18, 1853, was registered as the owner of 50 acres on lot 13, concession 11—where the *Globe* said the oil spring had been located—purchased from Luther Dunn for £250.* Three years later, he sold 40 acres on the same lot for £1,500. That Tripp would drill and dig on land he did not yet own is not surprising: in 1850 this was unalienated Crown land on which he was free to prospect.†

North America's first oil company

Tripp's first attempt to bring in an oil well at Bothwell would come in 1856. Meanwhile, Tripp's efforts were focused on producing a paving material by boiling down the bitumen at Black Creek into what was generally referred to as asphalt. In 1852, he petitioned the Legislative Council of Canada West to incorporate a company. By then, he had already "erected buildings and machinery for the manufacture of asphalt."‡ A third petition in 1854 asserts that "your petitioners have been for the last three years at great expense exploring various sections of this province for asphalt, lead, copper, silver, oil and salt springs, and the said Charles N. Tripp is owner in fee of two large asphalt beds in the Western District," as well as one oil spring and two salt springs, a lead vein in Prince Edward county, and land and mining rights "in various portions of this province."

* The purchasing power of one pound sterling in 1850 would be equivalent to £78.98 in 2006, using the U.K. retail price index (Lawrence H. Officer, "Purchasing Power of British Pounds from 1264 to 2006," www.MeasuringWorth.com, 2007) or roughly $160 in 2007 Canadian dollars. Both U.S. and U.K. currencies were legal tender in Canada during the colonial period. The Canadian dollar was first issued as national currency in 1868 (James Powell, *A History of the Canadian Dollar*, Ottawa: Bank of Canada, 2005).

† In pre-Confederation Ontario, unalienated Crown land could be either acquired by settlers as a grant, under one of a number of varying provisions, or else purchased from the government. As there were very few settlers in Enniskillen in the 1850s, most of those who sought mineral rights would have had to purchase the land from the government. Surface ownership included mineral rights, unlike the later situation in western Canada where after 1887 surface and mineral rights were treated separately. In Alberta, the government retained about 80 per cent of the mineral rights.

‡ For tabulation of 31 land transactions by Charles Nelson Tripp, 1853-1860, see Christina Burr, Canada's Victorian Oil Town (Montreal and Kingston: McGill-Queen's University Press), 48-49.

MAPLE SYRUP
Charles Nelson Tripp boiled bitumen at Black Creek into a form of asphalt, probably using maple sugar pots such as this one, shown in use in the Eastern Townships of Quebec, about 1925. After James Miller Williams found crude oil at the site of Tripp's bitumen, producers built simple stills by inverting such sugar pots, one on top of the other. Vapours from these stills condensed in pipes called worms. Williams at first used such pots for initial distillation at Oil Springs, discarding unwanted volatile fractions similar to gasoline, then hauling the residue to Hamilton for further distillation and processing to produce kerosene.
Credit: *McCord Museum, MCM 89015048.*

The charter granted on December 18, 1854, to the International Mining and Manufacturing Company (IMM) empowered the firm to "erect works for the purpose of making oils, paints, burning fluids, varnishes, and other things of the like from their properties in Enniskillen." This was 31 days before incorporation of the first American oil company, the Pennsylvania Rock Oil Company*, which collected oil from a surface seep at Titusville. IMM, with Charles as president, was authorized to issue shares with a par value of £60,000, a huge amount at that time.

The seven directors,† however, subscribed for only £8,750, and likely not all of that in hard cash. The team of directors and financial backers that Tripp assembled included himself and brother Henry; wood merchants Hiram Cook of Hamilton and John B. Van Voorhies of Woodstock; James L. Folger, St. Vincent, New York; and James Connon and William Ogilvie of New York City. Each director subscribed for 250 shares at £2 each, or £1,250. Charles Tripp very likely received his shares in return for assigning to the company the properties mentioned in the charter application.

Charles had long since quit his job at the stove factory in Bath and moved to Hamilton. An early task was to obtain an analysis of the bitumen. In 1852, the year that the first of four applications were made to incorporate IMM, a large sample of the bitumen was dug and hauled— probably in early winter when the frozen ground made hauling easier—19 miles northwest to Sarnia on the St. Clair River. From Sarnia, the raw bitumen, including twigs and roots, was shipped to New York for examination by consulting chemist and physician Thomas Antisell. In his report

* The Pennsylvania Rock Oil Company was incorporated in New York by lawyer George Bissell. The company collected small quantities of crude oil from surface seeps, and chemist Benjamin Silliman demonstrated in 1854 that this crude oil could be distilled into high-quality lamp oil. However, due to lack of finances, the company languished until new owners took over, renamed it the Seneca Oil Company, and hired Edwin Drake

† Most published histories fail to list the three New York directors.

These must have been heady days indeed for 32-year-old Charles Nelson Tripp. He had acquired a valuable resource, found financial backers, organized a company, dug bitumen, produced asphalt, secured testimonials to the value of his resource, and won a substantial foreign order, all in a remarkably short time.

dated February 19, Antisell described the sample as "a very valuable variety of Bitumen, and applicable to all the purposes for which this substance is now in such demand," for making mastics, cements, and for lighting purposes. Lighting was considered "its most appropriate use," in the form of either liquid or gas.

Tripp seemingly ignored that "most appropriate use" and continued to focus on producing asphalt by boiling the bitumen in open cast-iron pots, allowing the most volatile components to evaporate and simply dumping any liquid. Tripp did, however, send a 1,450-pound sample of bitumen to the Hamilton Gas Company, which on February 7, 1855 reported that upon heating, this amount yielded 4,600 cubic feet of gas in three hours, and that the gas provided 10 per cent to 15 per cent more illumination than gas distilled from coal. Another accolade was won that year when a sample of the asphalt was included in Canada's exhibit at the Universal Exhibition at Paris and received an honourable mention. Better yet, Tripp's company received a large order for asphalt to help pave the streets of Paris.

These must have been heady days indeed for 32-year-old Charles Nelson Tripp. He had acquired a valuable resource, found financial backers, organized a company, dug bitumen, produced asphalt, secured testimonials to the value of his resource, and won a substantial foreign order, all in a remarkably short time. He was starting to move in elite social circles. While his asphalt was on exhibit in Paris, he married 18-year-old Almira Jane Cornish, daughter of one of London's leading citizens, Dr. William King Cornish, a physician, coroner, and lawyer.

Tripp's misfortunes

Behind Tripp's sunny facade of success loomed a dark cloud of growing debt. One problem was acquiring ownership of the gum beds and other candidate properties he had prospected on Crown lands. Other parties had acquired much of this property, and Tripp had to buy it from them. As a land trader, he started out well enough, buying the 200-acre lot embracing the small east gum bed bitumen deposit for a reported £6 in May 1853, selling it two weeks later for £618.10, then buying the 200-acre west gum bed with the larger bitumen deposit for £250. But throughout 1853 and 1854, buying and selling Enniskillen's potential oil properties proved anything but profitable for Tripp. He is recorded as having purchased, probably for assignment to IMM, a total of 1,450 acres for £1,644, while selling 400 acres for £726, leaving him with just over 1,000 acres at a net cost of £918.[*] That was a big chunk of the company's money.

In an effort to raise more money by selling treasury shares, IMM published a large advertisement in Hamilton's *Daily Spectator and Journal of Commerce,* every week for six months in 1855, from the first week of February to mid-September. The ads consisted only of the full reports from Thomas Antisell and the Hamilton Gas Company, extolling the value of IMM bitumen and asphalt. If that resulted in the sale of any shares, it was not enough.

Creditors began to sue. From July 1855 to October 1857, 13 judgments were issued against Tripp (in some cases, jointly with an associate) for money owed, totalling £2,500.[2] James Miller Williams and Henry Cooper, partners in the Hamilton Coach Factory, won a judgment for £38, probably for the wagons that Tripp is reported to have purchased. Alexander Murray, the Woodstock farmer and GSC geologist who examined the smaller of the bitumen deposits in 1850, was owed £25. Largest item was £1,500 owed to John B. Van Voorhies, one of the IMM founding directors. The Bank of Upper Canada was owed £600. If nothing else,

* The 1880 Atlas of Lambton County says that Tripp "bought from the government" the two lots embracing the bitumenn deposit, "and several others in the district."

the list of obligations is testimony to promoter Tripp's ability to tap other people's money, without which no resource promotion can succeed.

From 1855 to 1857, all of the oil properties of Tripp and his International Mining and Manufacturing Company were lost, according to land transaction records,[3] with perhaps the exception of two parcels of 100 acres each. These two parcels were the first ones sold in 1855, purchased by Henry Tripp for a nominal 10 shillings (one-half of an English pound sterling). Henry, who was picking up the pieces of the shattered dreams of his older brother, was possibly holding these for Charles to protect them from creditors. The last of Tripp's properties to go was the 200-acre lot comprising the larger bitumen deposit on the west bank of Black Creek. This (plus six other lots) had been seized by Sheriff James Flintoff[4] for money owed to the Bank of Upper Canada and sold at public auction in Sarnia for £170. The buyer was Charles Sadlier of Hamilton, who was by then partnered with James Miller Williams and others as oil property buyers. That, effectively, was the end of IMM, the world's first incorporated oil company.

Early in 1856, Williams, in partnership with Sadlier, Angus Macdonald, and George Harris, both also of Hamilton, and John B. Van Voorhies, began to acquire Tripp's properties on and near the Enniskillen bitumen.*

Later that year, Tripp, now bankrupt, would leave Canada for prospecting in the United States, abandoning his young bride of less than two years. This, however,

* Williams' and his three partners "On 3 February 1856... purchased... lot 18 concession one and lots 16 and 17 concession two, from the financially distressed Charles Nelson Tripp. On 1 December 1858, Williams acquired 600 acres on lot 18, concession, and lots 16 and 17, concession two [the same property]... from Charles Sadlier." Williams did later buy out his three partners, but this confusion about land transactions suggests that Williams might not have had title to the gum beds until late 1858. Records of early land tranactions, under the land registry system, are often very unreliable. (See *Canada's Victorian Oil Town* by Christina Burr.)

THE DISCOVERY WELLSITE
Today at the Oil Museum of Canada in Oil Springs.
Credit: *Robert Bott*

The Chippewa Indians were said to have avoided the cholera epidemic of 1832 by the claimed medicinal powers of this oil. The Delaware Indians from the United States, who had been settled in the area by Moravian missionaries, made the first commercial use of Bothwell oil in 1844.

was not quite the end of Tripp's interest in Enniskillen oil properties. A decade later he would return from the southern United States with stories of high adventures and fortune, to sell at least one plot that his brother Henry apparently had kept in good standing by paying taxes. At the same time, Almira would make the top bid for a 200-acre parcel of her husband's former holdings, only to lose it when she could not produce the required deposit. The property then went to a lower bidder, William McGarvey, who became one of the most successful oil producers in Enniskillen, and later in Europe.

A near miss at Bothwell

Before heading south in 1856, Tripp attempted to sink, for Williams, a well at an oil seep on the bank of the Thames River near Bothwell. This village had been founded only the year before by *Globe* publisher George Brown, one of the future Fathers of Confederation.

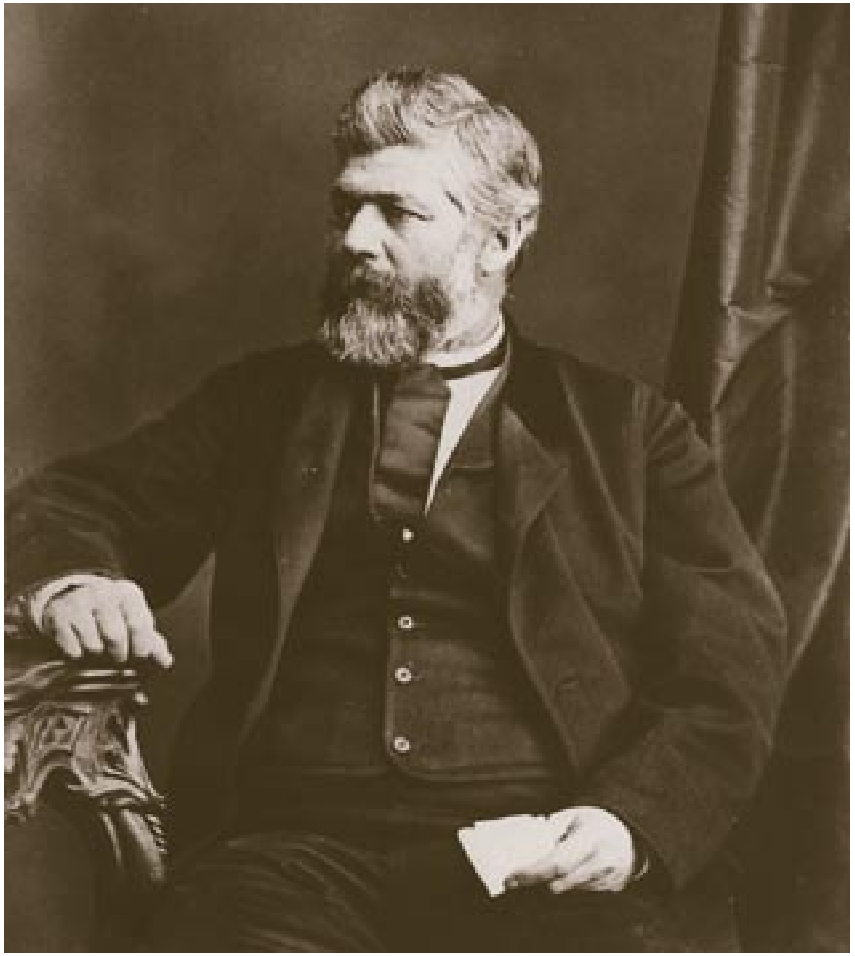
The bank of the Thames River, about two miles south of Bothwell and the same distance north of Moraviantown, was a good place to look for oil. This is where the first recorded find of an oil springs in Upper Canada was made;* where other oil seepages were found, and where a significant oilfield would much later be discovered. It was John Graves Simcoe, Upper Canada's first Lieutenant Governor, who noted the oil spring in 1793 during a 220-mile march from Newark (now Niagara-On-The-Lake) to Detroit. "A spring of real petroleum was discovered by its offensive smell," Lady Simcoe confided in her journal.[5] Scottish travel writer John Howison, in his 1821 *Sketches of Upper Canada,* noted that oil "flows from an aperture in the bank of the river, and three or four pints can be skimmed from the water daily." Ten years later, English farmer Joseph Pickering, in *Enquiries of an Emigrant,* observed that, at Moraviantown, "a singular spring of oil issues out of the banks of the rivers near here." The Chippewa Indians were said to have avoided the cholera epidemic of 1832 by the claimed medicinal powers of this oil.[6] The Delaware Indians from the United States, who had been settled in the area by Moravian missionaries, made the first commercial use of Bothwell oil in 1844. From a spring on a low bank of the river, they scooped up oil*, and water in kettles, boiled off the water† and sold the oil for $3 a gallon, as lamp fuel and medicine. The oil was burned by settlers in Betty lamps—shallow iron kettles with wicks that produced almost as much smoke and odour as light.[7]

It was a reporter for the Chatham *Planet,* on a tour in May 1863 of the "celebrated Oil Wells" of Bothwell, who reported the Williams-Tripp attempt to sink a well here. "South of Bothwell on the river Thames, a distance of about two miles from the village," eight wells had already been sunk when the reporter visited the site. "We proceeded to well No. 1—that is the first well commenced. This is located on the flat, on the immediate banks of the Thames, and was commenced by a Mr. Tripp, a Canadian sent by Mr. Williams of London." The well was reportedly dug to 27 feet when it "filled with water and oil." Tripp then attempted "to drive an iron pipe in this well, but when the pipe had been driven a considerable distance, it broke, and the well was abandoned. The well was commenced some six years ago."[8] It would actually have been commenced seven years earlier, before Tripp left Canada for the United States in November 1856, according to author Christina Burr.[9] At a greater depth, the hole would have been a paying oil well, and the discovery well of the Bothwell oilfield.

* Robert Bruce Harkness identifies the site of the oil springs as the Bothwell oil field. "Ontario's Part in the Petroleum Industry." *Canadian Oil and Gas Industries,* February and March, 1951

† Most components of crude oil have higher boiling points than water, so with moderate heat it would be possible to evaporate the water while keeping most of the oil. Kerosene, for example, boils at 175 to 325° C.

J.M. WILLIAMS
James Miller Williams brought in North America's first commercial oil well at Oil Springs, Ontario, and established the first successful, integrated oil company, with crude oil production, refining, and marketing operations.
Credit: *Lambton County Museums*



A promoter to the end

That Tripp was employed by Williams in this venture is not surprising. Tripp was broke, and Williams one of his creditors. But the idea of sinking a well at Bothwell was undoubtedly Tripp's. It was Tripp who got Williams interested in oil development in the first place, and it was Tripp who assiduously scouted for mineral prospects far and wide.

While the Enniskillen properties of Charles Tripp, now prospecting in the United States, were being disposed of, his young brother Henry picked up more than 2,700 acres between 1855 and 1860 in a dozen transactions. In some of these, Henry may have been acting for the absent Charles, and in other cases for the grass-widow Almira Tripp: for several years, until 1862, Henry and one Richard Martin acted as trustees for Almira's Enniskillen properties.[10]

On May 2, 1866, a few months shy of 10 years from the time Charles Tripp left Enniskillen Township, about 100 "leading oil operators from Oil Springs, Petrolia, Bothwell and Toronto" gathered at the Court House in London for a public auction of lots conducted by "Mr. Torbutt of the Crown Lands Department."[11] Among the bidders was Almira Tripp. She had her eye on a 200-acre lot that her husband reportedly purchased from the government in 1852[12] and later forfeited for non-payment of arrears. Located a scant mile northwest of the oil wells at Oil Springs and southwest of the newer wells at Petrolia, it was a prime oil prospect and the most sought-after parcel at the auction.

"Tripp himself is supposed by some to be dead, but this is doubted by others," the *Globe* reported. In fact, "Tripp himself" might have been at the sale; if he wasn't in the vicinity in May, he certainly was in August, waxing loquaciously to a newspaper man.

After failing to discover the Bothwell field in 1856, Williams turned his attention to distilling the Enniskillen bitumen, or gum bed, into a lamp fuel. This was a much different operation than Tripp's open-vessel "oil boiling" to make asphalt.

When Lot 16, 5th Concession of Enniskillen came up, Almira "proceeded to bid upon it, and it was knocked down to her at $61 per acre," or $12,200. "Mr. Torbutt then informed her that he would give her half an hour to make the required deposit of 10 per cent, failing which the lot would again be put up for sale." When the money was not deposited at the bank within 30 minutes, the lot "was knocked down to Mr. McGarvey"—the first reeve of the fledgling village of Petrolia, incorporated earlier that year—for $10,400, or $1,800 less than Almira had bid.

It was probably fortunate for Almira that she lost the bid: no oil was found on the 200-acre lot. Eleven years later, when it became the site of the junction of the Canada Southern Railway and the branch line of the Great Western from Wyoming to Oil Springs, a new settlement was established on this lot. It was optimistically named Oil City, but never grew beyond a village of about 100.

Was Almira acting on her own, or was the abortive bid made on behalf of her erstwhile husband? We will probably never know. What we do know is that Charles Tripp returned briefly to Enniskillen in August 1866, telling a reporter for *The Huron Signal* (Port Huron, Michigan, sits across the St. Clair River from Sarnia) that he had fought four years for the Yankees in the U.S. Civil War, amassed a fortune in Mexican silver mines, and had returned to Canada to collect $200,000 for Oil Springs properties that he said were rightly his.[13] If he failed to collect any of the $200,000, he is recorded at least to have collected $7,000 from the sale of a 100-acre parcel[14] before returning to New Orleans. There, in a lonely hotel room, he died on September 30, 1866, reportedly of "congestion of the brain." He was 43. His obituary reported that he had been in the southern states "for the past ten years," that he knew more "about the mineral wealth of every southern state than any other man alive," and had been busy organizing companies to develop "on a gigantic scale" deposits of "oil, copper, lead, zinc and iron" that he had discovered in Louisiana and Texas." He was truly a promoter to the end.

Shrewd businessman James Miller Williams

James Miller Williams was a well-established businessman when he turned his attention to the petroleum prospects of Enniskillen, his interest triggered by Charles Tripp.

In his home town of Camden, New Jersey, Williams had left school early to apprentice as a carriage maker, and in 1840, at age 22, moved to London in Canada West. A latter-day version of the United Empire Loyalists who had fled to Canada following the American Revolution, Williams was imbued with his British heritage, determined to settle in a British home, and had reportedly chosen Canada's London because of its name. He arrived with a 7-year-old sister, a 43-year-old housekeeper, and the bones of an infant brother buried more than 20 years earlier,[15] perhaps planning a family burial site on British soil. He also appears to have arrived with some money. Within two years, Williams had married and was a partner in a carriage-making business, soon buying out his partner.

A decade later, Williams moved from London to Hamilton where, by 1851, his Hamilton Coach and Carriage factory employed 70 men. His 17-foot Omnibus, capable of carrying 22 passengers inside and an additional 24 outside, was greeted by the Hamilton *Spectator* as "superior in every respect to any other in Canada, and...on the American continent," an "elegant travelling palace."[16] Williams partnered, once again, with Henry Cooper, and the firm became Williams and Cooper, makers not only of carriages for the rough roads of Canada West, but also the first cars for the Great Western Railway, completed from London to Windsor in 1853. (It was not until 1858 that Great Western built its London-to-Sarnia line, passing through Wyoming, 12 miles north of the future Oil Springs and 5 miles north of the Petrolia oilfields).

WELL CRIBBING
Angus Sutherland, foreman for Fairbank Oil Properties, in 1957, examines a plank from the cribbing of North America's first commercial oil well, sunk by J.M. Williams a century earlier. The Williams well is at the site of the Oil Museum of Canada at Oil Springs. The man seen in the hole is oil producer Paul Morningstar, being observed by his father (standing), Tony Morningstar.
Credit: *Lambton County Museums, 365642-01.*

In 1855, Great Western began making its own rolling stock, and Williams seems to have begun looking for a new field of endeavour. It was almost inevitable that Tripp, in need of investors for his new International Mining & Manufacturing Company, would make a pitch to Williams, but the shrewd carriage maker was probably too cautious to put money into that particular vehicle. Instead, Williams, together with his new partners, apparently decided to acquire Tripp's properties.

Putting the pieces together

After failing to discover the Bothwell field in 1856, Williams turned his attention to distilling the Enniskillen bitumen, or gum bed, into a lamp fuel. This was a much different operation than Tripp's open-vessel "oil boiling" to make asphalt. However, the potential was plain for Williams to see: Thomas Sterry Hunt of the GSC had reported seven years earlier that the bitumen contained a rich 80 per cent "volatile material." The plants of James Young in Scotland and Abraham Gesner in New York were by now making coal oil for lamps from oil shale and coal, and a new plant in Boston was making the lamp fuel from the albertite bitumen brought in from New Brunswick. Thomas Antisell, in the report that had been advertised for six months in the Hamilton *Spectator,* had said that a liquid or gas fuel for light was the most appropriate use for this "very valuable" bitumen.

To accomplish the task, Williams organized a new firm, J.M. Williams & Co., and eventually bought out the three partners with whom he had set out to acquire Enniskillen properties. Then, "on a gentle slope, between the creek and the fringe of the far-flung forest,"[17] he built a simple refinery.

He also created a big stink. The "offensive odour," as it was referred to, arose from the fact that the bitumen, and the subsequently discovered crude oil in Enniskillen, was "sour" in the parlance of the petroleum trade. That meant it contained

“A short time since, a party in digging a well at the edge of a bed of bitumen, struck a vein of oil,” yielding a “flow of almost pure oil” that was thought to have originated “far in the bowels of the earth.”

sulphur compounds including hydrogen sulphide (H_2S), which is toxic in very low concentrations and has a powerful odour of rotten eggs in even trace amounts. When burned, the sulphur compounds are converted into sulphur dioxide (SO_2) that has an unpleasant burning-match odour. Williams and his chemists would struggle for years to eliminate the odour, with only limited success. It would take 23 years before the problem was completely solved, by a new way of treating refined products. But people held their noses and bought the lamp fuel anyway, because this kerosene gave a better light and was very much cheaper than any other.

The Williams plant on the edge of the forest was ill-equipped to deal with the odour of rotten eggs or even to produce a particularly clear and clean fuel. It was more elaborate than the open iron pots in which Tripp had simply boiled the bitumen, but it was basically a still similar to the simple distilleries in which Canadians cooked grain mash, and Americans cooked corn mash, to produce whisky. At this plant, there were no repeated distillations and washing in acid and alkalis to remove impurities and reduce the odour. Williams soon moved his refining operations to Hamilton where more extensive distillation and treatment could presumably be carried out.

The 1858 discovery well

The historic Williams well found crude oil no later than July 1858. The first published report was in the *Woodstock Sentinel,* copies of which no longer exist. The *Sentinel* report was later republished in the *Sarnia Observer* on August 5. “A short time since, a party in digging a well at the edge of a bed of bitumen, struck a vein of oil,” yielding a “flow of almost pure oil” that was thought to have originated “far in the bowels of the earth.” The exuberant account predicted that:

> [T]he supply of fluid thus accidentally discovered will continue an almost inexhaustive source of wealth, yielding, at the lowest calculation, and with no greater flow than at present, not less than one thousand dollars per day of clear profit.

Williams and his diggers, and perhaps others searching for a supposed clear profit of $1,000 a day, were not idle in the weeks following the report of the discovery. The oil “seems to abound over a considerable tract of the land,” the *Observer* reported on August 26, “so that a hole dug 8 or 10 feet in width, and about the same depth, will collect from 200 to 250 gallons* a day.”[18]

The *Observer* noted that there were as of yet “no works for manufacturing the oil into a merchantable commodity at the site” and that the oil was being “barrelled up and sent to Hamilton to be prepared there.” Williams, however, “was taking steps for making available for the purpose of light, etc. by erecting works thereon for purifying said oil and making it fit for use” by refining at the well site “with as little delay as possible.” A sample of the oil, dipped in rag or paper, was said by the *Observer* to burn with a “strong light” and “dense black smoke,” but the paper added: “If clarified, however, we see no reason it should not make a splendid lamp oil.”[19]

Williams did “put up suitable works” at Black Creek, at least for simple distillation of the oil. It is not known what happened to the still in which Williams was said to process the bitumen just a year before this crude oil discovery; perhaps the facility blew up like so many other early stills. In any event, for a time Williams had two refinery operations going: a simple “pot still” at Black Creek turned out a first-run distillate, which he then hauled to Hamilton for further refining. It was a sensible thing to do. The type of pot stills used at Oil Springs in the following few

* One Imperial gallon holds 4.55 litres, while one U.S. gallon holds 3.79 litres. This reference would likely be in Imperial gallons, but it is often not clear in historical references which measuring system is being used.

HOLE IN THE GROUND MONUMENT

The record of wells drilled, or dug, in the search for oil and gas is littered with more failures than successes. That seemed equally true in the early days of Ontario's oil hunters, but one company at least gave up the search with a sense of humour. The following item appeared in the *Hamilton Times* and was reprinted in *The Globe*, Toronto, November 2, 1866:

OIL WELL ABANDONED

—The Bart Oil Company, who commenced drilling for oil in the township of Barton, about two years since, have finally abandoned their enterprise as hopeless, and offer their engine and apparatus for use in some more auspicious locality. The company have expended a considerable sum of money, and have "erected" a "monument" to unrewarded perseverance in the form of a hole in the ground to a depth of 878 feet.

years produced about half a barrel of distilled fuel for each barrel of crude oil they processed, while the other half evaporated or turned into unusable residues. The lightest vapours were vented into the air, and the rest of the byproducts were just dumped, according to historian Robert Harkness.[20] Even with the completion of the Great Western Railway through Wyoming in 1858, the same year Williams brought in his discovery well, transportation remained a huge problem, and the greatest cost facing Oil Springs producers for many years. Cutting in half the volume to be hauled, by disposing of waste at the production site, must have seemed an inspired cost-cutting opportunity.

Williams likely had his new still operating close to his new oil wells in the fall, within a few months of the discovery, but certainly no later than the following summer in 1859. By that time a traveller on horseback visited the site, and in a forest clearing of three or four acres found that "some log buildings had recently been erected... the dwellings of workmen employed, and the place for the preparation of the oil for market" by means of "a distilling apparatus."[21]

Next year, the distilling apparatus in the forest clearing was gone. Montreal Mining Engineer Charles Robb, in a paper to the Canadian Institute in February 1861, offered an explanation:

> At first the distillation was carried on at the wells, but latterly the percentage of loss in refining being so small (about 30 or 35 per cent), it was deemed expedient to remove the works to Hamilton, and convey the oil thither in barrels.[22]

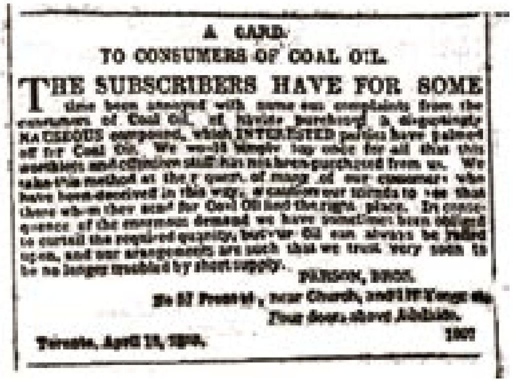
Thomas Sterry Hunt of the GSC, in his visit to the Enniskillen wells in December 1860, confirmed that Williams was shipping his oil to Hamilton, where:

> The process of refining consists in rectifying by repeated distillation, by which the oil is separated into a heavier part employed for lubricating machinery, and a lighter oil, which after being purified and deodorized by a peculiar treatment with sulphuric acid, is fit for burning in lamps.[23]

What really ended Williams' first-pass distillation at Black Creek was an explosion and fire that demolished the still in the forest clearing. A fire in March 1860 caused an estimated $3,000 to $4,000 in damages, the *Hamilton Times* reported on April 6, and on June 12, the still was burned down, the *London Free Press* reported. Williams was having a hot time not only at Black Creek, but also at his Hamilton operation, where flames engulfed his refinery causing $6,000 in damages, reported the *Hamilton Times*.[24]

The Williams discovery well was completed at 14 feet, according to the account and chronology of oil wells compiled by Mrs. Richardson (although the same well was deepened later by drilling, to a depth of 100 feet). The well was a seven-foot by nine-foot cribbed shaft in which oil and water rose to within 10 feet of the top, with the oil pumped out at rates of up to 90 barrels per day.[25] As already noted, the *Sarnia Observer* claimed that subsequent holes found oil as shallow as 8 or 10 feet. At these shallow depths, the oil was presumably seeping into holes at rates much slower than the flow encountered at greater depths. In the first two years, the discovery well produced only intermittently, reportedly yielding only 343 barrels of oil (that is, as little as one-half barrel per day). In part this was undoubtedly because of the difficulties of hauling away the barreled product, and also probably because the output of this and the other first few wells supplied all that Williams and Co. needed, as they struggled to establish their crude oil refining and marketing operations.

1859 ADVERTISEMENT
Kerosene (aka coal oil) refined by J.M. Williams from crude oil he discovered July 1858 drew the ire of Parson Brothers, Toronto distributor of U.S. kerosene, in this advertisement in the *Toronto Leader*, April 4, 1859, four months before the completion of the first U.S. oil well at Titusville. The "nauseous" odour in the Williams kerosene came from the sulphur content in southern Ontario's oil fields.



A CARD.
TO CONSUMERS OF COAL OIL.
THE SUBSCRIBERS HAVE FOR SOME [illegible]
PARSON, BROS.
[illegible]
Toronto, April [illegible]

1860 ADVERTISEMENT
A year after Parson Brothers complained about Ontario's "disgustingly nauseous" kerosene, J. M. Williams & Co. claimed that it had been able to "entirely remove this disagreeable odour," in this advertisement in the *Hamilton Spectator and Journal of Commerce*, July 4, 1860. In fact, it required another 17 years before the odour problem was completely solved.

OILS! OILS!! OILS!!!
J. M. Williams & Co.,
ARE NOW PREPARED TO FURNISH
Illuminating & Machinery Oils
of qualities equal, if not superior, to any in the market,
At prices much below all other Coal Oils.

THOSE who have any knowledge of the Coal Oil business are well aware that not a barrel of any of these oils has ever been manufactured either in Canada or the United States without great difficulties having been experienced, and large amounts having been expended in order to overcome the offensive odor common to all coal oils. This odour has prejudiced many against them, and has hitherto prevented us from bringing our oil before the public. But recent experiments have been attended with great success, and have resulted in our obtaining a process by means of which we can now entirely remove this disagreeable odour. We offer our Oils at the following

PRICES:
Illuminating Oil, 70 Cts. per Gallon,
Machinery Oil, 60 " " "

TERMS STRICTLY CASH.

LAMPS, LAMPS.

We have a large variety of Lamps, of the most improved styles, which we will furnish to our customers at the manufacturer's prices. As we purchase these Lamps in large quantities, and only for the accommodation of oil dealers, the public may be assured we will not be undersold.

CRUDE OIL.

We offer Crude Oil, delivered on the line of the G. W. Railway, at the following rates:—
In quantities of from 1,000 to 4,000 galls., [illegible] cents per gall. From 4,000 to 100,000 galls., 18 cents per gall.
J. M. WILLIAMS & CO.
Hamilton, July 4th, 1860.

Drilling deeper

Williams did more than just dig wells in the surface clay and glacial drift, if a newspaper report is correct. In 1859, the year after his discovery, he reportedly drilled what was then a deep oil well. This was the same year that "Colonel" Edwin Drake brought in the first American commercial oil well at Titusville, Pennsylvania. The Williams well was twice as deep as Drake's. To drill it, Williams made the first oilfield application of the spring-pole drilling rig (more fully described in Chapter Four) to "kick down" a heavy chisel-faced drill bit and sinker bar through the ground. "Well sunk [dug] 46 feet to rock; bored 100 feet in rock," the *Globe* reported on September 6, 1861. "It has been in operation two years." At 146 feet, the well reached a fractured limestone formation in which oil rose from the underlying main pay zone of Devonian reefoid limestone.[26] It would be another three years before a well punched into that lower, more prolific oil zone. At the 1862 International Exhibition in London, England, Williams won a gold medal "for introducing an important industry, by sinking the artesian wells in the Devonshire Strata for petroleum." He also won a second gold medal for "an extensive exhibition of the derivatives of petroleum."

The *Globe* report, however, is the only contemporary record of a deep well by Williams as early as 1859, and other reports refer only to the shallower dug wells. According to Charles Robb, "at Mr. Williams' wells the depth is only about 40 feet."[27]

By 1861, Williams had five oil wells, with intermittent production limited to the surface wells. The supply appeared to be adequate, without the need for any further costly deep holes. J.M. Williams & Co. by now had been reorganized as the Canadian Oil Company.* "About 100,000 gallons have been taken from two of our

* Canadian Oil Company was organized November 4, 1860, with five directors: Williams (president), three brothers, William P., John and Nathaniel Fisher, and Isaac Jameson. William Fisher was secretary. Williams held controlling interest with one-third of the shares, $14,000 of the $42,000 issued capital.

Less than four years after the Oil Springs discovery, with wells that reportedly flowed at rates of thousands of barrels a day, Enniskillen Township was viewed as an inexhaustible source of the world's cheapest lamp fuel.

wells during the last eighteen months [i.e., in 1859 and 1860] by means of a common hand pump," company secretary William P. Fisher wrote on January 7, 1861. This would be equivalent to about four barrels per day. "With the oil comes a large quantity of water, say one half, sometimes much more. We are now trying a steam pump with a view of testing the full capacity of our springs."[28]

Problems with "skunk oil"

Less than four years after the Oil Springs discovery, with wells that reportedly flowed at rates of thousands of barrels a day,* Enniskillen Township was viewed as an inexhaustible source of the world's cheapest lamp fuel. Professor H.Y. Hind of the University of Toronto said of the lamp fuel refined from the Canadian crude oil: [29]

> It is, at 45c a gallon, incomparably the cheapest illuminator which has yet been manufactured; and it threatens, for domestic purposes, to drive all other means of illumination out of the field.

It did just that. However, right from the outset, when Williams began marketing this refined "cheapest illuminator," months before the first American oil well, he had to deal with the difficult "skunk oil" problem caused by sulphur compounds in the crude oil. The problem is suggested by a brief chronology:

August 26, 1858, *Sarnia Observer* : "...we noticed the discovery, in the Town of Enniskillen, of an abundant supply of mineral oil, which the owner of the land was taking steps for making available for the purpose of light, etc. by erecting works thereon for purifying said oil and making it fit for use. Since making this announcement, a friend has brought us a small quantity of the oil, as a sample...The substance is of a dark color [sic], and has a strong pungent smell, but a piece of rag or paper dipped into it and afterwards ignited burns with a strong light emitting as a matter of course, on account of the impurities in the article, a dense black smoke. If clarified however, we see no reason why it should not make a splendid lamp oil."

September 23, 1858, *Sarnia Observer*: "Enniskillen oil—this most superior illuminating oil, can now be had from Mr. W.B. Clark, the agent for Sarnia, at $1.25 per gallon. The article, we have no hesitation in saying, after having given both a fair trial, is superior to the celebrated Albertine† oil, being more free of smell, while its illumination properties are equal if not superior to the latter in all respects... We see the oil is advertised in London at $1 per gallon."

December 2, 1858, *Globe*: Parsons Brothers of Toronto appointed "Sole Canadian Agency of the Excelsior Coal Oil Company," an American firm producing kerosene or coal oil from coal.

March 18, 1859, *Toronto Leader*: Parsons Brothers advertisement complains about the smell of "a disgustingly nauseous compound, which INTERESTED parties have palmed off for coal oil." It described it as this "worthless and offensive stuff," which could have been nothing other than the lamp fuel from Williams' Canadian Oil Company. Notwithstanding Parsons' complaint, Canadian Oil Company continued to refer to its product as "coal oil," even though it didn't come from coal.

May 31, 1859, *The Leader*: "We learn that Professor Croft [Trinity University, Toronto] has succeeded in deodorizing the natural oils found in the County of Lambton... all that was required before placing the oil in the market. Its

* Some of the early accounts of prolific flows were undoubtedly exaggerated. However, it is possible that high flow rates might have been experienced for short periods.

† Albertine oil was presumably kerosene refined from the albertite hydrocarbon mineral found in New Brunswick. At this time, such a product could have come from refineries in Boston or New York.

Parsons established a refinery in Toronto in 1861 to process, at first, sweet crude oil from Pennsylvania, and then Enniskillen oil. This enterprise became the predecessor of British American Oil Company, the largest Canadian-owned oil company in the early decades of the 20th century.

illuminating qualities are unequalled… Its price will be $1 per gallon, or 50 per cent below the price of the various coal oils now sold."

July 7, 1859. George Thompson, the keeper of the Burlington Ship Canal Lighthouse in Hamilton, writes in his journal: "Mr. Williams called, left 2 gallons of his manufactured coal oil." Three days later he added: "The quality of Mr. Williams oil scarcely as good as the Albertine oil."[30]

July 4, 1860, Hamilton *Spectator,* Canadian Oil Company advertisement: "…recent experiments have been attended with great success, and have resulted in our obtaining a process by means of which we can now entirely remove the objectionable odor."

January 7, 1861, in a letter to the Journal of the Board of Arts, Canadian Oil Company secretary Fisher says the company has spent "several thousand dollars" to improve its refining process, but declined, for competitive reasons, to provide details.

March 28, 1861, *Toronto Leader,* Canadian Oil Company advertisement: "We shall from this date furnish our customers with an Oil superior to any we have yet manufactured."

And so the search continued for kerosene that burned with a smell as clear and clean as the light it gave. But odour or not, the low price and quality of kerosene from crude oil drove even Parsons Brothers to embrace the "worthless stuff." Parsons established a refinery in Toronto in 1861 to process, at first, sweet crude oil from Pennsylvania, and then Enniskillen oil.[31] This enterprise became the predecessor of British American Oil Company, the largest Canadian-owned oil company in the early decades of the 20th century. Controlling interest in British American was acquired by Gulf Oil Corporation of Pittsburgh in 1956.

Collingwood shale oil

Kerosene from crude oil—the "incomparably cheaper illuminator"—quickly drove one competitor from the field, a shale oil works at Collingwood, Ontario, some 155 miles northeast of Enniskillen. For about two years, until some time in 1861, the Collingwood operation distilled up to 200 gallons (5.6 barrels) of oil per day from 20 to 30 tons of oil shale. A Geological Survey of Canada report noted:

> The cost of the crude oil was said to be 14 cents the gallon, and for a while the works were carried on successfully, a ready market being found for the oils; but the works were repeatedly destroyed by fire, and the oils from this source coming into competition with petroleum from the oil wells of Enniskillen, the enterprise is for the present abandoned.[32]

Canadian Oil Company was a great success for at least two decades, selling its Victoria Oil kerosene in Europe, South America, and Asia before intense competition apparently drove it into the arms of Canadian Carbon Oil Company, an amalgam of several leading Ontario refiners.

The oil business was but one phase of James Williams' multi-faceted career. His interest in Canadian Oil Company gradually passed to his son, Charles Joseph Williams, who purchased the company in 1879, about two years before it disappeared into Canadian Carbon Oil. The senior Williams established a new J.M. Williams and Company in 1871, one of the first firms in Canada to make pressed tinware, and sold that five years later. He was actively involved in four financial institutions and insurance companies, and three railways. After serving on the Hamilton city council, he was elected Liberal member for Hamilton in the Ontario legislature in 1867, 1871, and 1875. He died in 1890, age 72, having spent his last five years as registrar of Wentworth County. ■

CHAPTER 3

DISCOVERIES AND DISAPPOINTMENTS:

BOOM, BUST, AND CONSOLIDATION

"And wouldn't it be nice to be loaded with riches, not gained by freezing out some other fellow, by looting a bank, by wedding an unloved bride, by grinding the poor, by manipulating stocks, by cornering grain, or by practices that make the angels weep, but by bringing oil honestly from the bowels of the earth?"

– **John J. McLaurin,** *Sketches in Crude Oil,* Harrisburg, Pennsylvania, 1896.

"Some found their loads of riches, some lost everything they had, and some who found wealth still died impoverished."

Some found their loads of riches, some lost everything they had, and some who found wealth still died impoverished. Rich or poor, those who played the oil game in the second half of the 19th century saw boom-and-bust cycles more rapid, more violent, and more wasteful than experienced in any other big industry. It was the nature of the game. Due to lack of geological knowledge, their wells were wasting more oil than they knew, wasting not only oil that gushers spilled over ground, creeks, and rivers, but oil left trapped underground, unrecoverable because reservoir pressures had been depleted by oil wells packed almost as close as trees in a forest and produced as hard and fast as possible.

The operators' motive was not just the hunger to generate as much wealth as fast as possible, although that too was often a factor. Even more, it was the compulsion to dig or drill and pump as fast as possible because if you did not, your neighbour's well could drain the oil under your half acre.*

The boom-and-bust cycles went rapidly from oil glut to supply shortage, feast to famine, waste to want. Every rush of new wells flooded the market and sent oil prices crashing—not just in Ontario but even more so in the United States with its far greater number of new oilfields—while two or three years later the flush streams of oil turned to salt water, sending prices soaring, setting the stage for the next cycle. In Canada, during the first four decades of production, prices bounced, like a spring pole, between a high of \$11 and a low of \$0.25 per barrel, perhaps even \$0.10.

This fluctuation was a matter of basic economics, i.e., supply and demand. Prices fell rapidly if the oil production exceeded the market's ability to store, transport, and refine it and to sell the products. Prices soared if production was inadequate to meet the demand. The demand could vary too, according to general economic conditions, competitors' tactics, and factors such as transportation costs and bottlenecks. The boom-and-bust cycles occurred initially just within each local market, such as the Ontario or Pennsylvania oilfields, but as transportation improved, the cycles occurred over larger areas and often for longer periods of time.

It was not just oil men's fortunes that rose and fell, but the new oil towns also went boom and bust, sometimes more than once. Pithole, Pennsylvania, just 10 miles from the Edwin Drake's discovery well at Titusville, may have set the record. A wilderness in 1863, two years later it was a town of 15,000 with 50 hotels, and two years after that it was deserted, its frame buildings torn down and burned for kindling by neighbouring farmers. A lot in Pithole that sold for \$2 million in 1865 was auctioned for \$4.37 in 1878.[1] The pattern at Canada's new oil towns—Oil Springs, Petrolia, and Bothwell—was similar, if not quite as severe.

To escape the yo-yo cycle, Enniskillen oil men (and in the 19th century they were all men) organized cartels to control production, but the compulsion to drill and pump was too great, and each cartel collapsed. The only oil cartel to succeed for very long was John D. Rockefeller's Standard Oil Trust, which dominated the American oil industry until its 1911 breakup under American antitrust laws. Standard Oil was secretive, aggressive, oppressive in its tactics, generous with competitors who agreed to be bought out, and ruthless in crushing those who

* The "rule of capture" or "law of capture"—a common-law principle regarding resources found on or under your own property—still applies today in most crude oil and natural gas fields except where modified by well-spacing and resource-conservation regulations. The rule of capture also applies to groundwater and migratory fish and game. In the oilfields, it allowed well owners to produce oil that had migrated from the adjacent property of others. It was a major factor causing excessive oil production, greatly reducing the amount of oil that can be ultimately produced from a reservoir. The rule of capture was upheld as late as 1953 in a ruling by the Judicial Committee of the Privy Council in London, involving a dispute between adjacent property owners in the Turner Valley field of Alberta. (See Earle Gray. *The Great Canadian Oil Patch*, second edition, page 98.)

MACHINE SHOP
The Oil Well Supply shop in Oil Springs (unrelated to the Oil Well Supply Company in Petrolia) in the 1880s. The shop owners, Anderson and Murray, developed a gas-powered engine in the late 1880s, fuelled with natural gas from local oil wells. The shop has operated continuously and is now Watson's Machine Shop. Owner Murray Watson specializes in blacksmithing and metal sculptures. Credit: *Lambton County Museums EC 001 003 003*.

did not. It also brought to the industry a new standard of efficiency and a curb on waste. For consumers, Standard provided reliability, quality, and safety at a time when too often lamps fuelled with kerosene cut with gasoline exploded with deadly consequences. By the end of the century, Standard Oil would bring these vices and virtues to bear in a consolidation of the Canadian petroleum industry. The increasingly global nature of the oil industry, with many more producing fields and consumer markets and trading among them, also curbed the extremes of the boom-and-bust cycle.

Exciting times at Oil Springs

They were the first oil wildcatters in the world, those fortune seekers who flocked to dig holes along the bank of Enniskillen's Black Creek near James Miller Williams' discovery oil well, and 7 miles north along the banks of Bear Creek. Seventeen months after Williams' discovery, in December 1860, Thomas Sterry Hunt of the Geological Survey of Canada (GSC) visited the area and found that "nearly one hundred wells had been sunk"[2] to depths of anywhere from 40 to 160 feet. Most were "dry holes," the term wildcatters would use for wells that yielded no oil, though many produced water. Those that did yield oil were produced only intermittently because of a shortage of oak barrels and the difficulty of hauling the oil through the rain-soaked seasonal morass to the Great Western Railway at Wyoming. The first "oil diggings" had been pits dug by hand, but spring-pole rigs were now working, pounding drill bits through 50 to 80 feet of glacial drift to produce the first "rock oil" from a field now called Oil Springs.

Hunt reckoned that 300,000 to 400,000 gallons (8,500-11,500 barrels) of oil had been produced and hauled to the railway at Wyoming, where it sold for $0.13 per gallon or $5.46 per barrel.* That was the first noted price for Enniskillen oil. Williams was shipping his oil to Hamilton for refining, while the smaller volumes produced at Bear Creek, near the later site of Petrolia, were shipped to kerosene refiners in Boston.

The first real oil refineries—those that distilled, re-distilled, and washed their products in acids and alkalis—were being built by Williams in Hamilton, the Parsons brothers in Toronto, and a Boston firm on the banks of Bear Creek. Meanwhile, Oil Springs producers, in addition to digging and drilling wells, were busy erecting nearly 100 "refineries" of another type. These were simple once-through pot stills that yielded a dirty and smelly liquid fuel. A typical pot still has been described as two cast-iron maple sugar kettles, one inverted and sealed on top of the other. From the top of this globe-shaped still, an iron pipe led to a "worm," a tube in which the vapours of distillation were cooled and the kerosene condensed. The explosive and unwanted naphtha or gasoline vapours, the first to come from the still, were bled off by another, intersecting pipe between the still and the worm, and vented into the air. From the worm, the distilled but unrefined fuel was drained into a collection tank. "By this method, 50 per cent illuminating oil was gained," historian Robert Harkness calculated, "the remainder was lost †." [3]

Oil Springs, where most of the oil was still being produced, was already bursting at its seams, although British law and order made it comparatively quiet for a boom town: "no rows having taken place; knifing and shootings being

* The standard oil industry measurement was in U.S. gallons, with 42 gallons per barrel.

† The "lost" portion from early refining had two components, light and heavy. The more volatile hydrocarbons, including those which would later be captured and used as gasoline, were either vented as vapours into the atmosphere or dumped as liquids onto the ground or into the creeks. Meanwhile, the heavy hydrocarbons such as asphaltenes were left in the kettle after the light fractions boiled. These tar-like residues could be used as fuel under the kettle, dumped as waste, or further processed into products such as sealants and lubricants.

FIRST GUSHER SITE
Charles Oliver Fairbank II, in 1957, examines the collapsed well of Canada's first oil gusher. Using a spring-pole to chisel down to a new depth, John Shaw struck oil in 1862, and the oil flowed out of control for days. This historic site is part of Fairbank Oil Properties.
Credit: *Lambton County Museums, 36575-01*

No one knows how much oil was lost before John Shaw's gusher was brought under control. By the end of 1862, another 32 flowing oil wells were drilled at Oil Springs, the largest coming in at a claimed rate of 7,500 barrels per day.

entirely unknown," a newspaper reported.[4] Beds were so scarce that hotels rented bunks by the shift, the guests who retired early being wakened at midnight "so that other gentlemen might take a sleep." Near the main hotel ran "a small sluggish flowing stream":

> In it the diggers, covered with oil, washed their dirty selves after a day's work; swilled the mud off their boots, and quenched the thirst of their horses. From this ditch also was regularly procured the water of which the tea and coffee were made, and in which the fat salt pork, the staple article of food for long months, was boiled.

Getting the oil from Oil Springs to the railway at Wyoming was the tough job. In winter, a team of horses could drag a sleigh over snow, loaded with 14 to 16 barrels of crude oil or kerosene. Most of the rest of the year the trail to the railhead at Wyoming became one long mud stream, and wagons were sometimes abandoned in favour of "stone boats." A stone boat was a flat platform on skids, loaded with one or two barrels and drawn by horses through the mud. "To be compelled either to walk or ride the twelve-and-a-half miles between Wyoming and Oil Springs is a dreadful calamity," a *Globe* reporter wrote.[5] There were mud holes "large enough for horse and waggon [sic] to swim in," "broken wheels here and there," and "[w]aggons pushed aside into the bush or still sticking in the mud, and piles of lumber on the road, where attempts to reach Wyoming or Oil Springs have been abandoned in despair."

A solution to the transportation problem became urgent after January 16, 1862, when Canada's first oil gusher blew in at Oil Springs, spewing oil tree-top high. The gusher belonged to an itinerant American photographer, John Shaw.* Broke, his credit so exhausted it was claimed he couldn't replace his worn-through work boots, Shaw had persevered with his well for more than six months. He had dug a hole 50 feet through clay then drilled 158 feet before he hit the prolific pay zone.

* The confusion of Hugh Nixon Shaw with John Shaw arose with two historians, Robert Harkness and Victor Lauriston. In *Blue Flame of Service*, Lauriston described the discovery's attribution to John Shaw as "a tragic tradition" until Harkness uncovered the facts. According to Lauriston, "the best contemporary record is furnished by the Toronto *Globe*...[which] names the discoverer as Hugh Shaw." In fact, the *Globe* identified "a Mr. Shaw, lately of Port Huron, Michigan, a daugerrean artist, and formerly of Kingston West, struck oil," a description fitting only John, not Hugh Shaw. Four months later, the *Globe* refers to John Shaw by name, "a ruined, hopeless man..." until the well he had "centred all his hopes and expectations [on] for many long months" finally blew in. The first detailed record of early Oil Springs wells identifies "Well #6" as belonging to John Shaw. The known contemporary records identify the discoverer as John Shaw, while almost every account since the 1950s credits Hugh Shaw.

OXFORD HOUSE
Oxford House, one of nine hotels in the new Oil Springs boom town in the 1860s. Hotels were so crowded that that drillers had to take turns sleeping in beds, while in at least one hotel, men were reported to have slept "on counters and benches, on floors and planks."
Credit: *Lambton County Museums, EC 001 001 012*

CHRONICLE
Black Creek was in the middle of the Great Enniskillen Swamp when J.M. Williams brought in his discovery well; less than four years later, the new village of Oil Springs boasted its own weekly newspapers, which chronicled pioneer oil developments.
First issue of the *Chronicle* was April 23, 1862.
Credit: *Imperial Oil collection, Glenbow Museum, ip-1a-67*

The oil spilled over the ground and down the frozen Black Creek, from three to six inches deep, according to eyewitness accounts. To stem the flow, a 12-foot leather bag filled with flax seed was wrapped around the end of a 2 1/2-inch pipe and lowered down the hole. The bag swelled to form a seal between the pipe and the side of the hole, so that the oil came up only through the pipe. Another 3/4 inch diameter pipe, also wrapped with a flax bag, was lowered inside the larger pipe. Choked back through this smaller pipe, the oil continued to sprout to the tree tops, until this pipe was extended 20 feet into the air. At this point, the weight of the oil column was apparently sufficient to stem the flow. The crude oil was then directed into four storage tanks, each holding more than 120 barrels, and finally into oak barrels. A *Globe* correspondent claimed to have measured this restricted flow of oil at a rate of more than 8,000 barrels a day, a figure which seems extraordinarily high.[6]

No one knows how much oil was lost before John Shaw's gusher was brought under control. By the end of 1862, another 32 flowing oil wells were drilled at Oil Springs, the largest coming in at a claimed rate of 7,500 barrels per day. But by then, the oil men were better prepared to control the flow and contain the oil in storage tanks and barrels for shipping.

Petrolia was abandoned by drillers who rushed south seeking to share in the bonanza. The transportation problem seemed solved when a plank road from Oil Springs to the railroad at Wyoming was completed in May, four months after the Shaw well blew in. Now, 400 teams of horses could carry 16- to 20-barrel loads over the squared logs of the plank road. In barely more than a year, the new road was worn out, the timbers broken or sunk in the muck, and the price of oil had fallen from $4.00 per barrel to $0.40. Some oil sold for as little as $0.10 per barrel, according to an 1872 account by U.S. geologist Alexander Winchell of the University of Michigan and director of the state's Geological Survey.[7]

Suddenly, the flowing wells stopped flowing. After producing 35,000 barrels of oil, Shaw's well petered out in just 10 months. (This indicates that production had averaged about 117 barrels per day, a far cry from the initial claimed production of 8,000 barrels per day.) When Sanford Fleming visited Oil Springs in January 1863, he found the plank road "all but impassable," only two of the 33 flowing wells still flowing, and "not much fewer than one hundred refiners," many of whose stills were idle for lack of oil to refine.* The first Oil Springs boom was bust. Or perhaps it should be considered the second boom to go bust, for there had previously been a land rush as prospectors and speculators vied to acquire properties around Williams' initial discovery.

The sombre mood of depressed Oil Springs seemed reflected in the death of Hugh Nixon Shaw, who drowned in his own oil well on February 11, 1863. Shaw had been lowered 15 feet into his well to effect some repairs when he asked to be hauled up on the windlass, a witness at his inquest testified. The witness "[h]eard him drawing several long breaths, or breathing heavily; at that instant he fell back into the oil and disappeared."[8] It was not the first such death. Accumulations of hydrogen sulphide, carbon dioxide, or hydrocarbon vapours could all contribute to respiratory failure in enclosed spaces in and around the wells.

Perhaps even sadder was the fate of John Shaw. When his big well blew in, *The Christian Guardian* had said: "Everyone calls him a gentleman now, though many

* A surveyor and engineer, Sanford Fleming (1827-1915) went on to become chief engineer of the Canadian Pacific Railway, among many other achievements. He received a knighthood from Queen Victoria in 1897. (see *The Canadian Journal of Industry, Science and Art*, vol. VIII, 1863)

OIL SPRINGS PRODUCERS ASSOCIATION (1974)
Imperial Oil's last Oil Springs crude oil receiving station, closed in 1974. Here crude oil was unloaded, stored, then pumped to transfer the oil to railway cars. The building housed an office were producers received a receipt, and through the second door there was a five-horsepower motor pump.
Credit: *Oil, Gas and Salt Resource Centre, London, Ontario*

failed to discover the attributes of the gentleman, though really they were there, until Providence rewarded his indomitable energy."[9] According to petroleum historian John L. McLaurin, after his well stopped flowing, "Shaw became the victim of sharpers, lost his fortune, spent a short time at Titusville and Oil City [Pennsylvania]," apparently drifted back to Michigan, "earned a meagre livelihood taking pictures," and at age 42 in 1872, died "in abject poverty, like many another pathfinder before and since."[10] Shaw was buried at Titusville.

Fleeting prosperity

Just as oil prices fell when production rose, so prices soared as the gushers stopped flowing, hitting $10 per barrel by late 1865. Drillers and diggers were drilling and digging again, and the population of Oil Springs jumped from 600 to 2,000 in one year. The mire of mud that had been the main street was double-planked with white oak for a mile and a half. Horse-drawn buses ran the length of the best-paved street in Canada at five-minute intervals. Kerosene lamps on ornamental posts made nighttime Oil Springs the brightest town in Canada, and an urban spectacle such as had never been seen. Stage coaches made twice-a-day round trips to Sarnia on another 20-mile planked road. There were 12 general stores, 2 churches, 9 hotels, and a huge 108-room lodging being built by a Chicago firm.

As before, sleeping room was scarce. At the Exchange Hotel, "Men have been sleeping on counters and benches, on floors and planks, all the rooms to be got by packing two in a bed and half a dozen in a small chamber," the *Globe* reported.[11] It was said to be "impossible to sink a well without finding oil. Even the keeper of the 'Exchange' is forced to mix his tea and coffee, his gin and molasses with filtered rain water." When the inn keeper "gets short of money he has only to pull the lid from off his well, dip down his bucket, draw forth his oil, pay what he owes, and keep the rest." True or false, the tale of the innkeeper's well was the sort of heady stuff that kept men flocking to Oil Springs.

Yet once again the Oil Springs boom was short-lived, as drillers and diggers rushed north the following year, pulled by the lure of the first of the larger flowing oil wells at the site that would become Petrolia. The enduring feature of oil booms, like gold rushes, is the large, transient, mostly male workforce that flocks to the latest hot spot (like Fort McMurray in 21st century Alberta).

A committee of producers examined and reported on "the causes which led to the suspension of operations at Oil Springs, in the winter of 1866-67."[12] The cause was that the new, big flowing oil wells at Petrolia had once again flooded the market. From $10 per barrel at the start of 1866, the price fell to a range of $3.50 to $5.00 during the summer to as low as $0.25 by the end of the year, and "fluctuated between 25 cents and 35 cents till the winter of 1868-69," the committee reported. "All operations at once ceased" at Oil Springs, while at Petrolia "at least three-fourths of the wells were shut down, the price of oil not paying for its procurement, unless in very large wells." Oil Springs was once more depopulated, "Most of those who were producing at Oil Springs in 1866, having left here about the time they shut down their wells."

A return to reasonable prices and a railway spur connection to Wyoming were seen as the cure-alls: "Your committee are of the opinion that the oil region surrounding Oil Springs has been but slightly developed and have no doubt but numerous large wells will be obtained outside the present working limits." Alas, it was not to be. Oil Springs' production languished for 15 years, until

PETROLIA STATION
The Great Western Railway station at Petrolia has barrels of oil on the station platform, waiting for shipment, in this photo circa 1880-1898. The spur line from Petrolia 5 miles north to the Great Western's mainline at Wyoming was built in 1867 by the Petrolia oil producers, tired of waiting for the railway to do the job, and tired of hauling their barrels of oil over a plank road they kept sinking and breaking in soggy ground. The short spur line was profitable from the start and soon purchased by Great Western. John Henry Fairbank donated the land for the station.
CREDIT: *Imperial Oil Collection, Glenbow Museum*

nitroglycerine "torpedoes" were introduced to be exploded in wells, to shatter the rock and stimulate the flow of oil.*

Later drilling found more oil at greater depth. The ubiquitous torpedoes were brought to Enniskillen's oil wells in 1872 by Richard Isaiah Bradley, who had left his Petrolia home at age 17 to work in the oilfields of Pennsylvania where, as a foreman, he had seen the explosives' effectiveness in stimulating production.[13] Oil Springs' production reached its annual peak of 133,366 barrels in 1898,[14] i.e., averaging 365 barrels per day, but there was no return to the glory days. The population in 1880 stood at 522, and a writer observed that the town had "a most dilapidated and forlorn appearance; houses in all stages of ruin and decay, and general inactivity, being the chief features presenting themselves to a stranger."[15]

Deeper oil and early refining at Petrolia

Petrolia got off to a slow start. There were at least 16 wells producing a small volume of oil as early as 1861, followed in January 1862 by the first flowing well. From a depth of 563 feet, the modest gusher blew gas, oil, and water 15 feet into the air, before catching fire.[16] But for another four years the field grew only gradually, failing to produce enough to meet the modest needs of Enniskillen's first real refinery.

This facility was the "refining works" that Hunt had noted was being built in December 1860. It was actually built by the same people that he said were shipping the Petrolia oil to Boston. This would logically seem to be one of the U.S. coal oil refiners seeking a cheaper feedstock supply than coal, or perhaps they saw an opportunity to enter a new market. It might even have been the Downer Kerosene Oil Company, Boston's largest coal oil producer, which had acquired the first coal oil refinery, the New York plant designed by Gesner. As described by the *Globe*, it was not a small refinery the Bostonians built at Bear Creek:

> Close by the site of the principal wells, the Petrolia Refining Company have erected a refinery. The company is composed principally of Bostonians, with a capital stock of $200,000, of which $11,000 has been spent in the erection of the works.[17]

The facility had a storage tank for 600 barrels of crude oil. Wood-framed buildings housed six 15-barrel stills; a lead-lined tank where the oil was heated by steam pipes and agitated by blades resembling circular fans; a settling tank, and product storage tanks, all designed to turn out kerosene at rates up to 3,600 gallons per day. Assuming 50 per cent of the crude oil input was converted into kerosene (and that these were Imperial rather than U.S. gallons), the refinery would consume crude at a rate of about 200 barrels per day.

Nothing more in the recorded history of Petrolia appears to have been said of this large plant. Indeed, the authoritative *Imperial Oil Review* has claimed that "Petrolia's first refinery," a simple still, "was erected in 1865," four years later.[18] The Petrolia Refining Company's plant likely exploded, and perhaps burned to the ground, a not uncommon occurrence. The close proximity of crude oil, distilled products, open furnaces, and likely workers smoking, made fires and explosions almost inevitable. The Carbon Oil Company plant, said by the *Review* to be "the first of any size," "opened in 1871 and ran for a year, then exploded. A whole year was spent rebuilding it and on July 30—the very day it reopened—it exploded again."

* In 1864, a U.S. Army volunteer officer, Colonel E.A.L. Roberts, patented the use of explosives to stimulate production in oil wells. He travelled to Titusville in 1865 and amazed skeptical oil operators with the effectiveness of his invention. Fracturing or "fraccing" remains a standard well-stimulation practice in the oil and gas industry, though it is now done with compressed fluids, such as liquid nitrogen, instead of explosives.

PETROLIA 1866
Petrolia in the late 1860s. A visiting journalist at the time wrote: "Everything smells and even tastes of oil; everybody is covered with oil, thinks of nothing but oil, and talks of nothing but oil."
Credit: *Martin Dillon, Petrolia Heritage; image enhanced by Clouse Photo, Petrolia*

When drillers returned to Petrolia after the flowing wells at Oil Springs faltered, they had to reach deeper to find oil, about 500 feet below the surface. The foot-powered spring-pole rigs were replaced with 15-horsepower steam rigs that banged down heavier bits attached to the ends of ash poles. With the gradually increasing number of wells and supply of oil, the 5-mile haul to the railhead at Wyoming became an increasing burden. When Great Western declined to build a spur line, the producers, led by John Henry Fairbank, built the spur themselves.

It was at this time that Benjamin King, a former ship captain from St. Catharines, brought in Petrolia's first great flowing oil well, on November 23, 1866. Even choked back through a small-diameter pipe, the well flowed over the derrick for 41 days at an average rate of 265 barrels per day. Three weeks after the King discovery, the producers completed their railway spur line and later sold it to Great Western for a modest profit. The line paid for itself in eight months.

As had Oil Springs, Petrolia boomed and more so, only it never totally collapsed. In early 1865, it was a village of 6 log cabins; barely more than two years later there were 2,300 people, a school, stores, 4 churches, and 8 hotels. A few years later there were 4,000 people and 11 hotels. The hotels were valued as much for their bars as their beds, as Ontario's new laws limited the number of "wet" hotels to 1 for every 250 people. What was daily life like in these instant towns? A first-hand account by a visitor to Petrolia (quoted in an 1879 publication) gives some of the flavour: "To a stranger it is an exceedingly interesting place, *for a time,* but it requires a very short time to become monotonous. Everything smells and even *tastes* of oil; everybody is covered with oil, thinks of nothing but oil, and talks of nothing but oil. And still they are not happy, but are ever sinking more wells...."[19]

Nine months after the King discovery, much of the field was gutted in a fire that covered 20 acres and burned for two weeks. A dozen wells and wooden tanks holding 40,000 barrels of oil went up in flames. "Bursting steam boilers... sent fragments of smokestacks, derricks and flaming debris high into the air. Flaming oil raced down ditches into Bear Creek" giving "the appearance of a fiery dragon raging though the valley."[20] Such fires were all too common in the early oilfields, given the close proximity of boilers fired by wood or coal, crude oil leaks and fumes, and tobacco-smoking workers.

After the fire, oil was housed more safely in tanks installed into the nearly impermeable Enniskillen clay. The 8,000-barrel in-ground tanks were typically 30 feet in diameter and 60 feet deep. By 1912 there were said to be at least 50 of them, but they were starting to be replaced by 35,000-barrel steel tanks.[21]

Producer cartels

The Petrolia wells were not as spectacular as the big gushers at Oil Springs, but they had greater staying power. The Petrolia field held nearly twice as much recoverable oil, but spread out over an area 13 times larger. There was the same compulsion to drill and pump as fast as possible, with, as already noted, the same dire result: a flooded market and price collapse, to $0.25 per barrel. Many Petrolia wells were shut down temporarily, and all the Oil Springs wells ceased production for the next 15 years.

Whipsawed by boom and bust, producers, led by John Henry Fairbank, organized cartels time and time again. Attempting to limit production to match market demand, they managed only to revive fallen prices for anywhere from a few months to as long as two years.

This high-tariff wall, imposed by the supposedly "free trade" Liberals, remained in effect until 1904, by which time Canada's growing needs for oil outstripped the capacity of Ontario's wells.

At Oil Springs, the Canada Oil Association had sought to revive prices to $1 per barrel in the wake of the big flowing oil wells that followed Shaw's discovery, but prices bounced back only after the flowing wells stopped producing. At Petrolia, Fairbank banded producers together in the Crude Oil Association, which did raise prices briefly. More ambitious was the Lambton Crude Oil Partnership, signed on November 25, 1871 by 105 Petrolia oil producers, as well as "oil operators" from Oil Springs, London, and Toronto, and refiners and marketers from as far as Quebec City. This cartel managed to boost the oil price from $1.50 to $2.50 per barrel, with a separate price for export sales set at $1.70. But within two years, the price had fallen to just $0.70, and the cartel was abandoned. The Mutual Oil Association followed in 1877, bolstering prices and stimulating drilling for two years until "Black Friday," May 1, 1879, when the price crashed to $0.40 and the association died.[22]

More helpful than the cartels was the government, which in 1873 thwarted a threatened flood of low-cost Pennsylvania oil by imposing a duty of $2.52 per barrel on imported crude oil, a duty of anywhere from 100 to 300 per cent of the fluctuating price of American oil. In winning this protection, it did not hurt that the riding of Prime Minister Alexander Mackenzie was in Lambton County and his home base was Sarnia. This high-tariff wall, imposed by the supposedly "free trade" Liberals, remained in effect until 1904, by which time Canada's growing needs for oil outstripped the capacity of Ontario's wells. When the crude oil duty was dropped, the government paid refiners a bounty of $0.015 per Imperial gallon on each gallon of refined product.

Despite the booms and bust, Ontario producers and refiners at times enjoyed a thriving, if short-lived, export market: from 1870 to 1873, they exported 60

A CLUSTER OF DRILLING RIGS AT PETROLIA IN THE 1870S.
The derricks covered to provide shelter from winter snow and summer rain, were said to resemble Dutch windmills. But not all dericks were covered; a couple bare-timber derricks can be seen in the background
Credit: *Lambton County Museums*

George Brown's Globe covers the oilfields

GEORGE BROWN
The Great Western Railway, in 1853, built a line from Hamilton to Sarnia, passing through 4,000 acres that Toronto *Globe* publisher had acquired two years earlier. Brown established the town of Bothwell on the railway line, and after oil was discovered at Black Creek 25 miles to the northwest, the *Globe* devoted more extensive coverage to the development of the industry than any other newspapers. When Brown sold most of his Bothwell property, he wrote to his wife, "Woman, you are rich."
Credit: *Library and Archives Canada, C-00955*

"In accordance with instructions, your correspondent proceeded to Bothwell, township of Zone, in the county of Kent, as the most available spot from which to visit the oil region."

Thus began a 3,100-word article in the *Globe*, Toronto, August 27, 1861, the first of a three-part series about the oil region of Canada West in British North America's most powerful newspaper. In each of the four-page issues that the oil series ran, it filled two or more of a total of 12 or 13 densely-packed news columns.

There would be numerous additional oilfield series in the *Globe* during the next two decades. Indeed, it was a rare week that the paper failed to feature one or more items about the new oil region.

It was not surprising that the *Globe*'s "own correspondent" would be dispatched to Bothwell, 15 miles southeast of Oil Springs, to begin the first series in the same year that the Bothwell oilfield was discovered: the village of Bothwell had been founded just six years earlier by *Globe* founder and publisher George Brown, long-time leader of the Reform Party, (predecessor of the Liberal Party), and one of the Fathers of Confederation.

Aside from his newspaper business and political career, Brown bought 4,000 acres of forest in Kent County in 1851. Brown knew where the Great Western Railway was going to be built two years later: right through the middle of his property. Brown hired 100 axemen to cut the cord wood that fuelled the railway's locomotives. When Great Western agreed in early 1855 to establish a station on Brown's estate, he laid out a new town and named it Bothwell. He built roads, sold village lots and farm lands, and established a large farm as his own rural retreat. He owned or had an interest in nearly every business in Bothwell's first years: a grist mill, saw mill, a mill manufacturing doors, sashes, and singles, cabinet factory, foundry, machine shop, and a potash business that turned waste forest slash into a saleable product. Within a year of its founding, Bothwell boasted a population of 450, one general store, and five taverns.

In 1865, two years after the spectacular discovery of oil, Brown sold his interest in the region, except for his farm, to the Bothwell Land and Petroleum Co. for $250,000, and wrote to his wife, telling her, "woman you are rich." But the *Globe*'s interest in the oil region never flagged.[23] •

That was Bothwell's first boom and within six years it was completely bust. With flush production, the wells that followed rapidly on the heels of Lick's discovery soon began producing more salt water than oil.

per cent of their production, mostly to Britain and Europe, but also with sales in South America and Asia. The United States, with its own rapidly increasing production, had no need for imports from Canada. Prior to 1900, Lambton County supplied 90 per cent of the oil needs of the Dominion of Canada.

The Bothwell saga

The birth of the third significant oilfield in Canada West followed a long gestation period. It was 70 years from the time that Lieutenant Governor John Graves Simcoe in 1793 made the first recorded sighting of an oil spring, near the banks on the lower reaches of the Thames River, as noted earlier, until production began from the Bothwell field.

In August 1863, seven years after Tripp and Williams failed to sink their hole deep enough to discover the field, a visiting reporter for the Toronto *Globe* found no less than six wells within about 3 miles of Bothwell, dug or drilled to depths of as much as 70 feet.[24] All had encountered natural gas and "very promising" shows of oil, raising confident hope that commercial quantities would very soon be found. Work at four of the wells had been temporarily suspended, however, as American drillers and investors rushed home to join the Union Army in the Civil War. Toronto prospectors named Duncan and Clark had found water mixed with oil at 36 feet, the *Globe* reported. They cribbed* their well with four-inch planks, were installing a pump to get rid of the water, and "will proceed vigorously with the shaft, being determined to solve the oil problem."

John M. Lick, the only American operator at Bothwell who did not rush off to join the war, had driven a seven-inch cast-iron pipe 70 feet into the ground, and was drilling in rock, "beneath which he expects to find oil." Finding it took a little longer than expected. Two years and a few dry holes later, on April 1, 1863, Lick found the Bothwell pay zone at a depth of 224 feet, his well initially producing oil at a rate of up to 200 barrels per day.

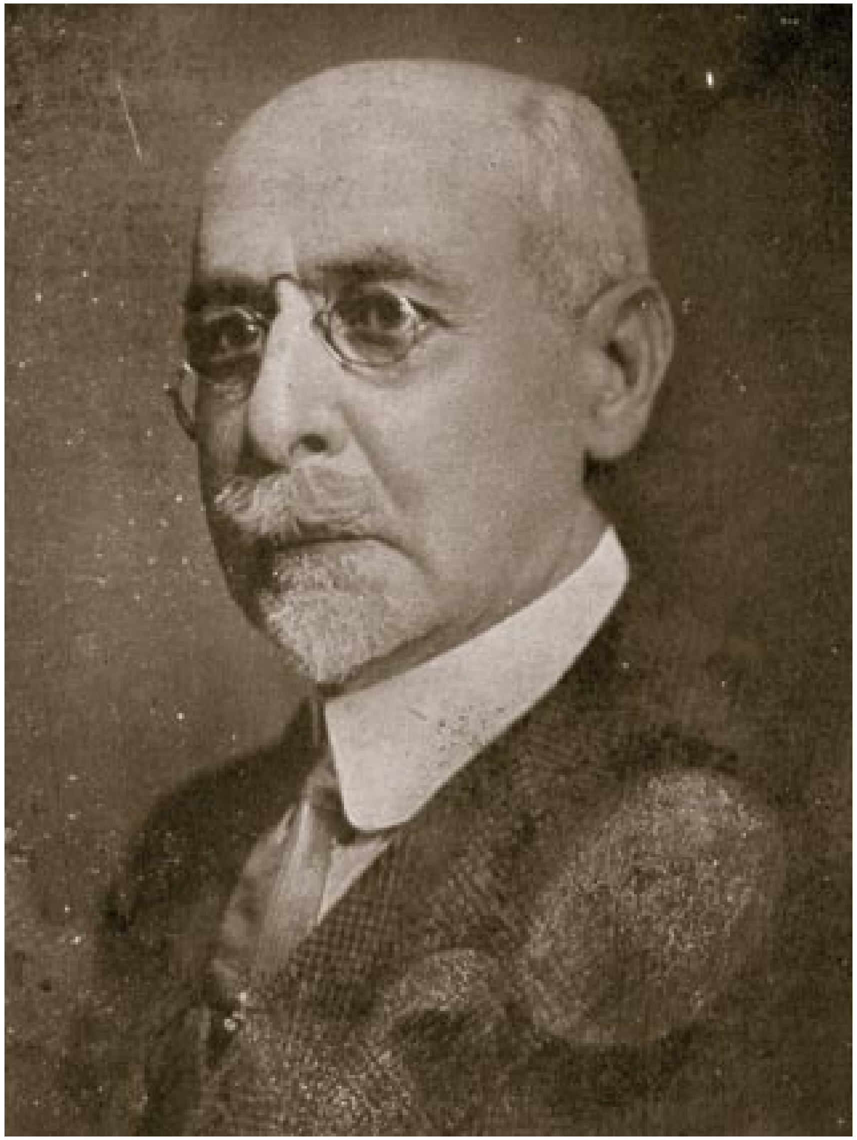
With a railway nearby to haul the oil out and haul equipment and supplies in, the Bothwell boom was more frenzied than those at either Oil Springs or Petrolia. A visiting American reporter wrote that compared with this "great oil region... even Pennsylvania must in future be content to play 'second fiddle.'"[25]

That was Bothwell's first boom and within six years it was completely bust. With flush production, the wells that followed rapidly on the heels of Lick's discovery soon began producing more salt water than oil. It did not help that the price of oil at Bothwell collapsed from $12 to $2 per barrel in the endless, violent swings from supply shortages to gluts. When Fenian† Raiders briefly captured Fort Erie in June 1866, the American oil men feared a British-American war might break out and they again fled home. Bothwell was left with 31 wells pumping diminishing volumes of oil, 172 abandoned wells, and a rising tide of salt water. In 1867 the field was completely shut down, and remained abandoned for 29 years until American Frank J. Carman and Dr. Charles Fairbank brought in a prolific well that extended the field's limits. The second boom was underway. Within two years, in 1898, Bothwell production hit its all-time peak of 66,404 barrels, equivalent to an average of 182 barrels per day.[26]

The Bothwell field was never really big, but its booms were spectacular. Soon after the 1863 discovery, the village of 500 became a roaring town of 10,000 with 25 hotels, a music hall, and numerous bars. The career of John Lick, the persevering

* Cribbing is a wall-like structure used to stabilize the sides of a hole. Wood is commonly used for cribbing, though stones or other material can be used for this purpose.

† In the 1860s, the Fenian Brotherhood recruited many Irish immigrants to the United States in an abortive campaign to invade Canada and thus force Britain to grant independence to Ireland.



JACOB ENGLEHART
Jacob Lewis Englehart arrived in Enniskillin from New York City at age 19, carrying money from the illicit sale of whisky, to enter the oil business. He became the principal founding shareholder of Imperial Oil, and one of Ontario's most respected 19th century business leaders. Credit: *Martin Dillon, Petrolia Heritage*

wildcatter, mirrored the boom and bust: he became rich and built one of Bothwell's grandest hotels, which in due course became a white elephant in a ghost town, and Lick died bankrupt.

Founding Imperial Oil

The individual who would bring stability and order from the chaos of boom and bust to establish Canada's largest oil company, started his career as a teenager loaded with money from the sale of bootleg booze. Nineteen-year-old Jacob Lewis Englehart arrived in Enniskillen in 1866 to establish J.L. Englehart and Company, "engaged in refining, producing and exporting petroleum." He had a plan to control the oil business in Canada the way Rockefeller's Standard Oil Trust controlled it in the United States. In a manner of speaking, he ultimately succeeded.[27]

Englehart had started work at age 13 as an office boy in the New York firm of Sonneborn, Dryfoos and Company. The principals were whisky rectifiers, which meant that they re-distilled and blended raw "corn likker." Before the Civil War, whisky was sold untaxed in New York for $0.24 per gallon. To help pay for the war, the U.S. government imposed a tax on whisky that began at $0.20 per gallon and rose to $2.00 per gallon before the war was over. The only whisky dealers to survive such heavy taxation were bootleggers making illicit sales. The Sonneborn firm was one that survived—at least for a time—providing Englehart with his startup capital.

Englehart neither looked nor acted like any typical teenager. Immaculately dressed in dark, vested suits with high-starched collars and a flower in his lapel, he sported a Vandyke beard and a ribbon that dangled from a pince-nez perched on an angular nose. In Petrolia he became a broker, buying kerosene

HERMAN FRASCH
Chemist Herman Frasch was hired by Imperial Oil to remove the odour of kerosene refined from Ontario oil. Before he completed this task, he was hired by Standard Oil, for whom he finally solved the skunk oil problem. Standard's control of the process developed by Frasch gave it a competitive advantage over Imperial Oil and was a factor in Standard's acquisition of controlling ownership of Imperial in 1898.
Credit: *Imperial Oil collection, Glenbow Museum*

from the many small Ontario refineries and shipping to overseas markets through the New York facilities of the Sonneborn company. He built a refinery in London, which he had to rebuild after it exploded twice within a seven-week period. When a German buyer refused to pay for a shipment of smelly kerosene, Englehart dismantled the simple refinery, shipped it to Germany, and re-distilled the kerosene there.

Despite a promising start, Englehart and Company struggled during the deep recession that began in 1873. Work was suspended until new financing was found from Isaac Guggenheim, a member of a family that was on its way to become one of the wealthiest families in the United States following a bonanza investment in a silver mine in Cripple Creek, Colorado. With the Guggenheim money, Englehart built the Silver Star refinery at Petrolia, said by author Patricia McGee to be "the world's largest and most sophisticated refinery"[28] for its time.

In 1880, Englehart launched one more effort to establish a Canadian cartel. His goal was to roll all the oil interests into one combine that would emulate the Standard Oil Trust in the United States. Most of the Ontario oil men agreed to join in the new enterprise, with two notable exceptions: James Miller Williams' Canadian Oil Company, and John Henry Fairbank, then Ontario's largest oil producer, who also controlled two small refining companies. The 19 founding shareholders of Imperial Oil contributed $25,000, a dozen refineries, and sundry oil wells to establish the new enterprise on April 30, 1880. Its mandate was "to find, produce, refine and distribute petroleum and its products throughout Canada."

Imperial's biggest asset was Englehart's Silver Star refinery. London businessman Frederick A. Fitzgerald was president. Englehart was vice-president, managing director, and with a 12 per cent interest, the largest shareholder. Ten of the 12 refineries acquired by Imperial from its founders were dismantled: only the Silver Star in Petrolia and another in London remained. When lightning and fire destroyed the London plant, an expanded Silver Star became the company's only refinery. Within three years, Imperial was marketing its products through 23 branches from Halifax to Victoria. Its kerosene, packed in five-gallon tins or oak barrels, lumbered across the prairies on Red River carts drawn by oxen.

Standard Oil prevails

Promising though this consolidation seemed, Imperial still faced formidable competition, most notably from Rockefeller's Standard Oil Trust, which seemed bent on achieving in Canada the dominance it held in the United States. In the 1880s, Rockefeller controlled 80 per cent of U.S. petroleum refining capacity, 90 per cent of the pipelines, and 90 per cent of the marketing. In Canada, its principal subsidiaries were the Bushnell Oil Company, a refiner, and Queen City Oil Company, Ontario's largest petroleum wholesaler. By 1889, Bushnell had bought eight small Ontario refineries, every one except Imperial's Silver Star at Petrolia. Bushnell dismantled seven of its eight new refineries and spent $150,000 to make an idle refinery at Sarnia into Canada's largest, surpassing Silver Star in capacity, refining costs, and product quality. Standard negotiated secret, preferential railway rates with Canadian Pacific and Grand Trunk. Secret discounts were the most powerful tool the trust had used in dominating the U.S. oil industry, a pressure tactic described by historian Allan Nevis: "Of all the devices for extinction of competition, this was the most deadly yet conceived by any group of American industrialists."[29]

PETROLIA REFINERY
Imperial Oil's refinery at Petrolia in 1893. Built by Jacob Englehart in the late 1870s as the Silver Star refinery, it was reputedly the world's largest and most sophisticated at that time. It became Imperial's principal asset when the company was organized in 1880. By the late 1890s, this refinery and a Standard Oil plant at Sarnia were the only two refineries in Ontario. When Standard Oil acquired control of Imperial in 1898, it shut down the Petrolia plant and concentrated refining at Sarnia. But three years later, Canadian Oil Refining Company built a Petrolia refinery, which operated for half a century.
Credit: *Imperial Oil Collection, Glenbow Museum, ip-1a-16a*

Solving the sulphur problem

Standard had yet another competitive advantage over Imperial: a patented method to fully remove the sulphurous stink of sour crude that had for so long placed Canadian "skunk oil" at a disadvantage with sweet, low-sulphur Pennsylvania oil. The method, ironically, had been largely developed by Imperial.

Herman Frasch was a brilliant German-American chemist who sold Imperial a distillation process that yielded more kerosene from each barrel of oil. Imperial then hired Frasch at the same salary it paid president Fitzgerald, made Frasch a director, and assigned him the task of finding a solution to the skunk oil problem. Frasch worked on the problem for 10 months, then left Imperial in 1886 to become a partner in a new venture, Empire Oil Company, which built a refinery that was said to produce kerosene that was 30 times cleaner than any other lamp oil produced in Canada.

Standard, by this time, had its own skunk oil problem, with the discovery in 1884 of large, sour crude oilfields in the Lima area of Ohio, where the trust controlled half the oil production. Frasch returned to the United States and perfected the desulphuring process, using copper oxide to make sour oil sweet. Standard patented Frasch's process in 1887, much to the bitter chagrin of Imperial Oil.

Standard Oil—with its newer, bigger, better, lower-cost Sarnia refinery; with its more extensive marketing network; its secret preferential railway rates for hauling refined products; its exclusive use of the only method to fully remove the stink of skunk oil—had Imperial in its vise, and the vise was being tightened.

In the 1890s, Imperial faced three options: find some powerful help to fight Standard, sell out, or face the prospect of being driven under. To build its war chest, Imperial negotiated a conditional sale of the controlling interest to the Colonial Development Corporation of London for $585,000. But after the English company dithered for more than two years without concluding the deal, Fitzpatrick travelled to New York and cut a deal with Rockefeller's trust. The agreement dated October 13, 1898, was typically generous: Imperial Oil would acquire all of Standard's Canadian subsidiaries, Imperial shareholders would receive more than $810,000, and Standard Oil would wind up owning 75 per cent of Imperial. Under its new ownership, Imperial closed the Silver Star refinery, moved its head office from Petrolia to Sarnia, and built a pipeline to move Petrolia crude to the Sarnia refinery. As late as 1920, Imperial still held 90 per cent of Canada's oil refining capacity and supplied nearly two-thirds of the market. Although this would prove to be the high water mark of Imperial's dominance, the consolidation of the Canadian petroleum industry had been achieved.

For Englehart, Imperial's largest founding shareholder, the deal meant nearly $190,000 in cash, a retained interest of almost four per cent in a larger, more profitable company, and, for a time, a generous salary as vice-president. There was, however, another challenge awaiting the man who had arrived nearly 40 years before to establish J.L. Englehart and Company with money from bootleg booze. In 1905, Ontario Premier James Whitney called on Englehart to take over management of the government's troubled Timiskaming and Northern Ontario Railway, then being built to serve the mines and mining camps of northern Ontario. Englehart saw the line completed, put it on a paying basis, served as chairman for 15 years, and had the town of Englehart named for him. When he died in 1921, he was one of Canada's most respected business leaders and philanthropists.

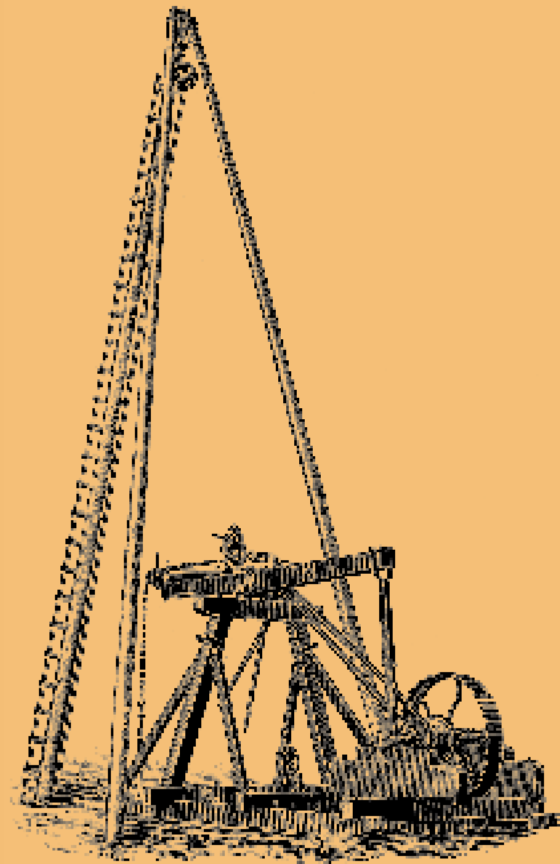
SARNIA REFINERY
Imperial Oil's refinery at Sarnia in 1890s. When Standard Oil acquired control of Imperial in 1898, it shut down the Petrolia plant and concentrated refining at Sarnia. But three years later, Canadian Oil Refining Company built a Petrolia refinery, which operated for half a century.
Credit: *Imperial Oil Collection, Glenbow Museum*

The nineteenth century production record

Despite the booms and busts, the gushers that too quickly turned into salt water wells, and the wild oil price gyrations, Canada's oil production generally grew thoughout the final four decades of the 19th century, albeit with some ups and downs in year-by-year output. Virtually all of the nation's oil production during this period came from Ontario's petroleum peninsula, primarily from Enniskillen Township. Until almost the close of the century, production exceeded the nation's oil needs, so that Canada was an oil exporter, mostly in the form of refined kerosene.

By 1868, 10 years after the Williams discovery at Oil Springs, and the first year for which official oil production data are available, Canada's annual output amounted to a reported 190,000 barrels (i.e., averaging 521 barrels per day).[30] Output peaked in 1894 at 829,000 barrels (2,271 barrels per day), but 30 years later that had dwindled to a mere 161,000 barrels (441 barrels per day), and much of that national figure in 1924 came from Alberta. In 1899, production of 809,000 barrels (2,216 barrels per day) was still 99 per cent of Canada's needs; 1899 is the first year for which "apparent consumption data" are reported. Thereafter, Canada's oil production rapidly fell far behind its growing needs throughout the first half of the 20th century.

As we shall see in later chapters, Canada's petroleum supply situation changed dramatically in the second half of the 20th century, and continues to evolve. In the first decade of the 21st century, Canada produces more than 1,000 times as much crude oil and equivalent annually as in the peak year in the 19th century. ■



CHAPTER 4

PETROLIA'S HARD OILERS DRILL THE WORLD:

For almost 70 years the "hard oilers" from Lambton County found, developed, and produced oil and gas fields and built pipelines and refineries in more than 40 countries, in every corner of the world. They took with them knowledge, experience, and skills learned at Oil Springs, North America's first commercial oilfield, at the larger Petrolia field, and at Bothwell. To areas as diverse as the Arctic and the Gobi desert, they also took with them the early oil technology they had developed in Lambton County, most notably the Canadian pole-tool drilling rig and the "jerker line" system of oil well production (to be described later). They were in the vanguard in finding and developing the petroleum resources of western Canada, where members of later generations of former Petrolians still work.

J.H. FAIRBANK
John Henry Fairbank (1831-1914) gambled all he had and all he could borrow to bring in an oil well at Oil Springs. After turning down a $600 offer for a half interest in his property, he worried that he had possibly been "very foolish." But within a few years, he became Canada's largest oil producer.
Credit: *Library and Archives Canada, PA 28347.*

Pioneer oilfield technology

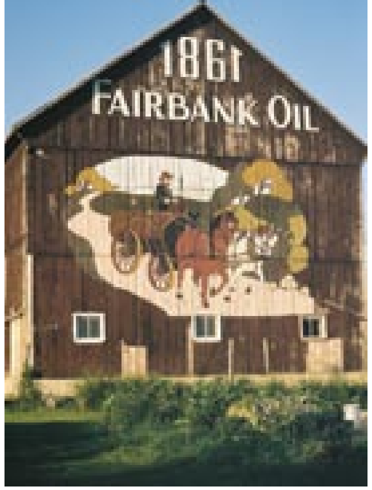
Today, the stories of the hard oilers, their equipment, and tools are on display at the Oil Museum of Canada in Oil Springs, at the working exhibits of the Petrolia Discovery, and at Fairbank Oil Properties, which still produces at Oil Springs on what is believed to be North America's oldest producing oilfield.* Many wells at Oil Springs and Petrolia are still produced by the "jerker line" system developed by John Henry Fairbank in 1863.

The Oil Museum of Canada preserves the site of what may have been the world's first registered petroleum company (Charles and Henry Tripp's enterprise), North America's first commercial oil well (James Miller Williams' 1858 well), Canada's first commercial oil refinery (James Miller Williams' facility), and an array of artifacts, working exhibits, historic photographs, and foreign driller memorabilia. The museum serves as the welcoming gateway and point of orientation to the considerable oil heritage assets of Oil Springs, Petrolia, and the rest of Lambton County.

Petrolia Discovery is an operational historic oilfield covering 60 acres with outdoor displays of producing wells, historic equipment, and several heritage buildings. The 1903 Fitzgerald Rig, now electrified in its original pumphouse, survives as the largest oil pumping rig of its type in the world.

Fairbank Oil Properties, a private oil company, produces oil from some 350 wells on 600 acres of the Oil Springs field. Today, the property is operated by Charles O. Fairbank III, John Henry's great-grandson. In addition to the wells

* Oil Springs is sometimes described as the world's oldest producing oilfield. However, crude oil appears to have been produced fairly continuously since the 10th century A.D. to the present in the Yenangyaung area of central Burma (Myanmar), initially from surface seepages and pits, later (and currently) from drilled wells. Similarly, production has continued at least since 1649 in Romania, where cribbed pits penetrated as deep as 816 feet in the 19th century before drilled wells were introduced.



FAIRBANK BARN
The barn at Fairbank Oil Properties in Oil Springs commemorates John Henry Fairbank's first oil production in 1861. Oil is still produced from the same property by John Henry's great-grandson, Charles Oliver Fairbank III.
Credit: *Earle Gray*

with their jerker lines, the Fairbank property is home to some of Canada's first historic petroleum sites, including the site of John Shaw's 1862 flowing oil well, Canada's first oil gusher, and the last original three-pole derrick still standing in Enniskillen. Public access to the private property is arranged for key events, or by special arrangement through the Oil Museum of Canada.

These are the principal sites of Lambton County's Oil Heritage District, which has been nominated for a United Nations World Heritage Site designation.

The most important of Canada's unique contributions to early oilfield technology are the jerker lines and the Canadian pole-tool drilling rigs.

John Henry Fairbank

Born in Rouse's Point, New York, the grandson of a settler who fought the British in the American War of Independence, John Henry Fairbank moved in the 1850s to Canada West where he married the granddaughter of a Loyalist who had fled the new United States to remain British.* As Fairbank later recalled: "At the age of twenty-one I came to Canada and followed surveying. I admired Niagara Falls, also one of its daughters, which annexed me to Canada."[1] The Niagara Falls daughter whom he married was Edna Crysler, and with her he settled down to surveying, and farming, on the Canadian side of the Niagara River.

A surveying job for a wealthy Niagara Falls widow, Mrs. Julia Macklem, took Fairbank to the developing oilfield at Oil Springs in March 1861, less than three years after the Williams discovery, and less than a year before Shaw's great wild well set off an explosion of speculative activity and drilling. Mrs. Macklem had purchased 100 acres at Oil Springs, the former property of the bankrupt Charles Tripp, and Fairbank's job was to subdivide this into 198 half-acre lots for sale or lease to wildcatters and speculators.

The pattern at Oil Springs was to dig or drill four wells on each half-acre lot. Ninety years later, when the mechanics of petroleum reservoirs were understood and Alberta's first big oilfields were being found and developed, the minimum spacing pattern in most fields was 40 acres per well, and after 1964, 160 acres per well. Natural gas wells were spaced 640 acres, i.e., one per square mile. Wider spacing prevented wasteful loss of pressure. The practices at Oil Springs left much of the oil trapped in the reservoirs.

Fairbank was soon smitten by the wildcatter's bug. After finishing the surveying job for Mrs. Macklem, he borrowed $500 from his father-in-law, leased a half-acre plot from Williams for $300 with $30 down, and dug and cribbed a well through the clay. Work on the well was temporarily halted while he and a partner bought lubricating oil from the pot stills of the new Oil Springs refiners and sold it to farmers along the Great Western Railway, clearing a profit of $0.15 from each gallon sold for $0.25. "Don't I hope to own a small refinery, or part of one," he wrote to his wife back home on the farm in Niagara.[2]

Fairbank got his wish, but it was no sudden bonanza. A year after leasing his half acre, he had drilled below the clay, and on some days was able to pump a little oil. "Old Fairbank," he called the well. He had a cantankerous still from which he could sometimes coax a little kerosene. Producing and refining would be limited to days when he was not busy cutting firewood, building a skid road, hauling in supplies, or hauling out a wagon load of kerosene to the railway at Wyoming, sometimes with hired help.

* For a detailed account of the Fairbank saga, see Patricia McGee's *The Story of Fairbank Oil*.

WALKING BEAM AND JERKER ROD
A pumpblock at Fairbank Oil Properties, Oil Springs. The pumpblock consists of a horizontal walking beam held in place by a samson post. As it nods up and down, it lifts and lowers the valve assembly below. The jerker rod system has been used at Fairbank Oil since J.H. Fairbank devised it in 1863. The jerker rod delivers power to the pumpblock from the powerhouse.
Credit: *Earle Gray*

In October, he cursed his still in his diary: "Run till dark and quite resolved that I won't run a damn leaky old kettle that acts as if it would 'go up' at any minute... Can stand work as well as anyone but damn a leaky still them's my sentiments." His first Christmas day on the lease was spent "minus turkey and such like. At work in mud and oil all day."[3]

To keep things going, he borrowed more money from his mother and his father-in-law, who mortgaged his Niagara Falls real estate, and drew on credit from local suppliers. He was sued four times in 1863, the last time by his mother (a ploy to keep other creditors at bay for a few months). That August he turned down an offer of $600 for a half interest in his lease, well, and still, then worried in his journal that he had been "perhaps very foolish."

The turning point came in November when he coaxed 45 barrels of oil from his well in 24 hours, and noted: "Net profit of day $150, a big day's work, the biggest ever made by me or probably I shall ever make."[4]

How wrong he was. He sold his half-acre Oil Springs property in 1865 for $6,000, focused on bringing in deeper wells at Petrolia, and in the late 19th century and early years of the 20th, was Canada's largest oil producer. At Petrolia, he opened "the largest hardware store west of Toronto."[5] Fairbank also helped finance the railway spur from Petrolia to Wyoming, and later the Canadian Pacific Railway; opened a savings and loan institution and, with a partner, a bank; acquired a business that made boilers, tanks, and stills for the oilfields; was chief of Petrolia's volunteer fire brigade, and served one term as a Liberal member of Parliament. Shortly before his death in 1914, he still owned 485 small producing oil wells at Petrolia and Oil Springs.

Fairbank's jerker rods

In the 1860s, Fairbank developed a new system of oilfield production ideally suited to the numerous, closely spaced, low-output wells of Lambton County.

His inspiration came from an oil well that was "too hard to work by man power"[6] and consternation at the cost of pumping oil wells once production fell from a relative flood to a trickle. It was a Canadian breakthrough in oilfield technology, "practically revolutionizing the whole existing plan," according to petroleum historian Victor Ross.[7] It was a system, added Ross, that "was quickly followed all over the United States" and in several other countries where the hard oilers worked.

This new system enabled a single steam engine*, usually of no more than 12 horsepower, to pump dozens of oil wells, replacing steam engines or manual pumping that would have been required at each well. The resulting cost savings made it economically feasible to produce hundreds of small oil wells that would otherwise have been abandoned, as well as providing low-cost power for wells that were too deep and "too hard to work by man power," as Fairbank phrased it.

In Fairbank's system, one engine pumps 100 or more oil wells by pushing and pulling, slender wooden rods, suspended by hangers a few inches above the ground, stretching across an oilfield. The rods connect at each well to a walking beam that teeter-totters on a vertical post called the samson post. One end of the walking beam† is connected to the pump that lifts the oil; the other is connected to the jerker rods. The rods swing back and forth in reciprocal motion, pushing

* These steam engines would have been stoked initially with cordwood cut in nearby forests, but later they could have been fuelled with coal or even refining residues.

† Walking beams, commonly seen today on "horsehead" oilfield pumps, are simply levers that oscillate on a pivot and transmit power in a reciprocating motion.

JERKER RODS AND FIELD WHEEL
This technology is still used today to produce oil at Fairbank Oil Properties in Oil Springs.
Credit: *Robert Bott*

and pulling the walking beam and its attached pump up and down. The whole apparatus is called the "jerker rod" or "jerker line" system. The jerker rods do not run out from the steam engine (housed in the "power plant") in a single straight line; horizontal "field" wheels change direction of the lines to connect with the oil wells.

Fairbank might not have been the first to use this type of system. Something similar was used in the mining industry in Germany, although it is unlikely that any Enniskillen oil producer was aware of this. Technology writer Norman Ball cites three Enniskillen producers said to have used steam engines for more than one job before Fairbank.[8] One used a six-horsepower engine to pump two wells that "are very close together." One used a steam engine to pump one well and drill another. A third used a steam engine to pump a well and power a saw mill. But Fairbank was the first to adapt a multiple pumping system on a large scale.

Fairbank told the 1888-1889 Royal Commission on Ontario Mineral Resources that in 1863, as he recalled the date, he did not have a steam engine for his one well that was too hard to work by hand "but there was engine power within reach and I applied the present jerker system." Jerker rods changed the economics of oilfield production. "When we had large wells we would abandon a well that produced only five or six barrels a day; now the man who gets a well of that kind is considered to strike it rich," Fairbank told the Commission. Now, in 1889, "Wells are not abandoned till the production falls to a few gallons."

In Pennsylvania and other U.S. producing regions where the jerker system was used, the wooden rods were soon replaced by iron rods or steel cables because of greater producing depths. But wood, iron, or steel, it was still the same jerker system.[9]

Some of the approximately 400 wells still producing oil at Petrolia and Oil Springs today are pumped by small electric motors at individual wells, but about 200 still being produced by wooden jerker rods, just as they were nearly a century and a half ago. The only significant difference is that the engines driving the rods are now electric, rather than steam. Some jerker rods still pumping oil, producing more than 130 barrels per day from 20 wells, can be viewed at the Petrolia Discovery outdoor exhibits. The power plant driving the jerker rods features the "Fitzgerald Rig," named after the man who built it in 1903, Frederick A. Fitzgerald, first president of Imperial Oil. With a bull wheel that is 22 feet in diameter, the Petrolia Discovery claims the machine is the world's largest oil-pumping rig.

The most extensive network of operating jerker rods is operated by Charles O. Fairbank III on his 600-acre site, covering more than half of the Oil Springs field. Of the 350 wells on Fairbank Oil Properties that produce 25,000 barrels of oil per year, more than 150 are operated by jerker rods and the rest by individual electric motors. Charlie Fairbank, however, is connecting more of the electric-powered wells to the jerker rods. One reason for switching to jerker rods is that this cuts electric power consumption by two-thirds. But the real reason, he explains succinctly, is that "Oil Springs is a legacy and transcends the individual. It is the creation of all the men who ever worked here. It reminds us of our beginnings.... It teaches men the elements of our business."[10]

BEAM AND THREE-POLE RIG
A pumpblock, the pioneer precursor to the pumpjack, frames one of Ontario's last original three-pole derricks. The derricks were used with a team of horses to raise and lower pipe for repairs and maintenance. Credit: *Earle Gray*

Petrolia's "hard oilers"

> "Our Petrolia correspondent informs us that there is almost complete prostration of business at that place; the labourers are leaving, and that the work of development is making slow progress. The oil refiners limit their operations strictly to the wants of the home market, which means that nearly all of them are shut down, and waiting for a favourable turn in prices."
> – Sarnia *Observer,* November 28, 1873.*

An economic depression crippled much of North America for a decade. As described in the previous chapter, a bust in the boom-and-bust cycle collapsed production and activity in the oilfields of Ontario. Yet drillers in the United States kept busy finding and developing new fields to meet the domestic and export demand.

These were the causes of a 70-year exodus of the "foreign drillers" of Petrolia, known among themselves as "hard oilers." They played key roles in finding and developing large oilfields in Indonesia, Mexico, South America, and the world's largest petroleum storehouse, the Middle East. Nowhere did the hard oilers play bigger roles than in Central Europe where, for decades, nearly all oil wells were drilled by "the Canadian drilling system," and either manned or managed by Canadians. Here they established booming businesses, a major industrial enterprise, and fortunes great and small. But the dreams, the fortunes, and in many cases the very lives of the hard oilers in Europe perished in the flames of the First World War.

"The famous Canadian drilling system," as J.E. Brantly termed it in a monumental history of oil well drilling,[11] was a distinct phase that dominated much of the world's well drilling technology for about 80 years, from 1860 to 1940.

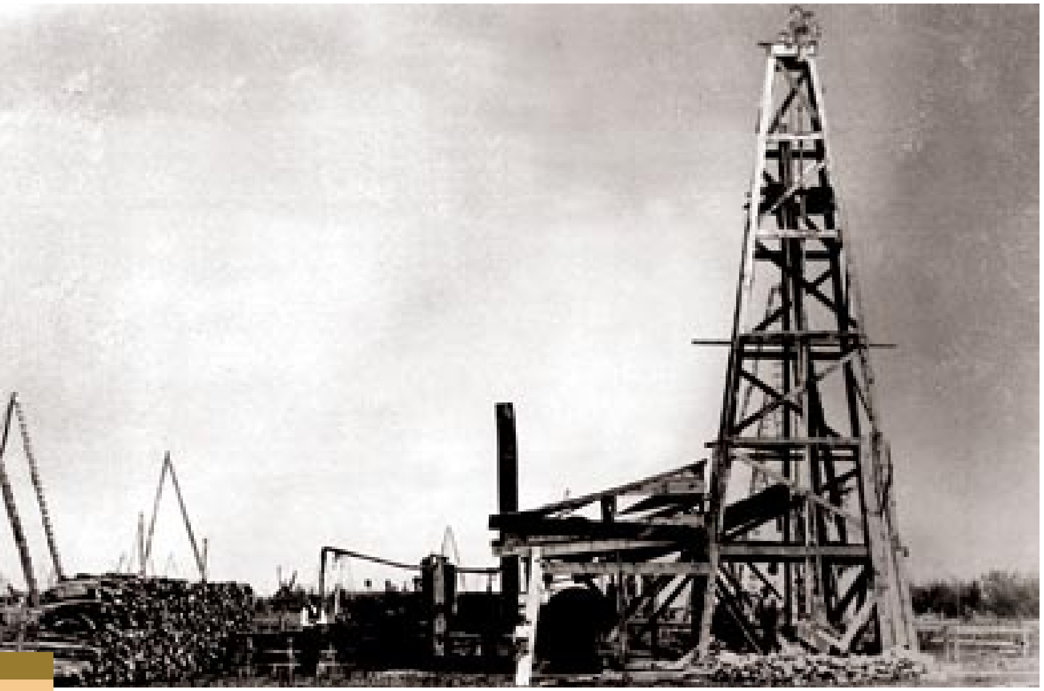
* The saga of Petrolia's foreign drillers is graphically told in Gary May's *Hard Oiler: The Story of Canadians' Quest for Oil at Home and Abroad.*

Early drilling methods

There are four basic methods in drilling wells. Percussion drilling dominated the first six decades of the oil and gas industry, while rotary drilling has predominated since about 1925. The other two methods are augered holes—using a screw device, similar to those used in post-hole digging—and driving open-ended iron pipes into the ground, pile-driver fashion; these methods found only limited, early use for some shallow wells. The Canadian rig used one variant of percussion drilling; Americans used almost exclusively until the 20th century, the other version of percussion drilling, cable-tool rigs.

Percussion drills were not suitable for drilling through the first 40 to 70 feet of heavy clay, silt, sand, and gravel at the Oil Springs and Petrolia fields because the pounding bits bogged down in the clay. Thus early wells were hand dug and cribbed down to bedrock, then drilled deeper. Later the surface layer was drilled through with augers; these were powered initially by horses that walked in circles around the well, and then by steam engines. Auger bits weighing from 25 to 250 pounds were attached to wooden poles and drilled holes 4 1/2 to 12 inches in diameter. The augered holes were much smaller than the 6- by 10-foot hand-dug and cribbed shafts.

Driven pipe was sometimes used in attempts to reach bedrock, but often failed. At Petrolia in 1861, a Mr. Fowle attempted to sink a 50-foot hole by pounding sections of iron pipe 1 inch thick and 6 3/4 inches in diameter with a 1,200-pound wooden hammer powered by a small steam engine. But the pipe was stopped by a large boulder at 41 feet, and had to be drilled out.[12] Charles Tripp is also thought to have used a steam engine and a wooden hammer in his attempt to drive down a well at Bothwell, also frustrated by a boulder.



RIG & FIREWOOD
A drilling rig a Petrolia, circa 1870, seen in summer, as indicated by the driller in shirtsleeves. In winter, derricks were covered with boards to protect drillers and machinery from snow and cold. Note the ubiquitous pile of firewood for the steam engine boiler. Note also the two drillers sitting poised at the top of the derrick.
Credit: *Oil, Gas and Salt Resource Centre, London*

The first known percussion wells were drilled for brine by the Chinese more than 4,000 years ago using bamboo rigs and winches, raising and dropping heavy bits to pound, pound, pound, down through the ground. It took generations for the patient Chinese to drill a hole as deep as 3,000 feet. The first percussion hole drilled in the Western Hemisphere was completed on January 15, 1808 near Charleston, West Virginia, by salt producers David and Joseph Ruffner, who sought (and found) a deeper and better source of brine.* It took the Ruffner brothers 18 months to drill their well. By digging and pounding, they drove a hollowed-out oak log, 4 1/2 feet in diameter, through 18 feet of surface material, then fashioned the first known spring-pole drilling rig to drill through 40 feet of bedrock, then cased their 2 1/2 inch hole with wooden tubing. The spring-pole drilling rig and some form of well casing (usually iron pipe) became the basic technology for hundreds of water and brine wells in the following decades, and then for thousands of oil and gas wells in the first decades of the petroleum industry. If the water, brine, or oil would not flow to the surface from its own pressure, simple pumps using leather cups† as non-return valves would lift the fluid to the surface.

The spring-pole rig consists of a cantilevered pole, perhaps 20 feet in length, anchored to the ground at the butt end and levered about one-third from the butt on a Y-shaped fulcrum fashioned from a fork of a trunk and branch of a tree. The drill bit and other downhole tools hung from the thin end of the pole, attached by wooden or iron rods, manila rope, or cables. With ropes and stirrups, drillers kicked down then allowed the pole to spring back, pounding the bit through the hole. The stirrups were soon replaced by treadles, on which drillers rocked back and forth to lower and spring back the spring pole. John Shaw used a spring pole rig to drill his famous gusher at Oil Springs in 1862 to a depth of 158 feet.

The Ruffner brothers attached the drill bit for their brine well to sections of iron rods, while subsequent drillers turned to wood poles, but not for long. Drake used rods for his 1859 Titusville well, but by the following year, Brantly reports:

> Rods predominated in use in America until about 1860 and drilled at least a few wells to depths exceeding 2,000 feet. However, with the beginning of the oil industry in 1859 and the increasing availability of manila line and the development of hosting machinery, rods were largely discarded in the United States for the faster and more convenient lines. Iron or steel and wood rods continued to be used on Canadian rigs and in Europe.

That is how Canadian and American drilling technology differed. In U.S. drilling, the manila rope was soon replaced by steel cable, and thus it was cable-

* The Ruffners found brine initially at a depth of 59 feet, and later much more at 410 feet. The brine was then evaporated with wood- or coal-fired furnaces to produce salt. Salt was a highly valued commodity in early 19th century North America because it was needed to preserve butter and meat before refrigeration. The Ruffners joined with other saltmakers to form the first U.S. "trust," a combination to regulate the price and quality of salt and deter foreign competition. It dominated the trade until the Civil War.

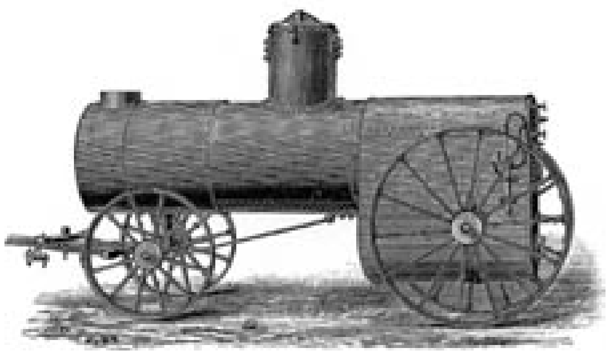
† A machine shop in Petrolia still makes leather cups and other parts for the pumps used in historic oilfields.

SPRING-POLE DRILLING
Spring-pole drilling at Petrolia in the 1880s. The two men on the left activate the pole by rocking back and forth on the treadle, raisings and dropping the bit to chisel its way through rock.
Credit: *Oil, Gas and Salt Resource Centre, London*

tool rigs that drilled nearly all of the early American oil wells until the first decades of the 20th century. Canadian drillers continued to develop and improve percussion drilling with rods, first wooden rods and later, especially in Europe, iron rods. The wooden rods were probably cheaper than cable. Ash poles, close at hand, were chosen because they were strong and straight-grained. Canadian drillers claimed that their poles or rods drilled straighter holes than the cable-tool and rotary rigs. In addition, cable hitting the side of the hole could cause cave-ins while drilling unconsolidated formations; the U.S. wells were generally drilled through solid rock, so cave-ins were not a big problem there, but Canadian and European wells often had to penetrate layers of sand and gravel in alluvial formations.

Another important Canadian innovation was the use of "jars" above the drill bit. Jars are interlocking, sliding joints that help transmit more energy to the bit and also assist in removing it if stuck in the hole.

Walking beams were first used shortly after the Ruffner well, and for several decades walking beams and spring poles were both used—to drill wells and to pump brine, water, or oil—until the spring pole eventually disappeared. The first walking beams were powered by horses walking on a treadmill, then by steam engines, and finally by diesel or electric engines. Early walking beams in the oil fields were 16 to 20 feet long, about a foot thick, tapered toward the ends, and sat on 8- to 10-foot samson posts. By 1884, the walking beam on a standard American cable-tool rig was 26 feet long, balanced on a 13-foot samson post.[13] The first steam engine at Oil Springs was hauled in by sled during the winter of 1860-1861. By mid-1861 there were reported to be four steam engines powering walking beams to pump oil, with three other walking beams drilling new wells, and more steam boilers and engines on their way to the oil region.



PORTABLE BOILER
"A drilling boiler on wheels" provided portable power for the steam engines of Canadian drilling rigs. From the catalogue of the Oil Well Supply Company, Petrolia, circa 1900. The Petrolia firm was a leading supplier of equipment for oilfield operations throughout the world.
Credit: *Courtesy Fairbank Oil Properties*

Even with the help of steam engines, percussion drilling is slow and laborious because of the frequent need to pull the drill string so that rock cuttings can be "bailed" from the bottom of the hole. After the string is pulled, water is poured in if it is not already present into the hole. The bailer, a tube with a trap door in the bottom, is lowered on a rope or cable to collect the muddy mixture of rock cuttings and water. Drillers then reassemble the drill string and resume pounding down the bit until it is again necessary to bail.

Rotary drilling, introduced to the oil and gas industry in Texas at the end of the 19th century, is much faster and more efficient because it eliminates the need for bailing. Drilling fluid is continuously circulated down the drill pipe, through the drill bit, and up the outside of the hole (the annulus) to remove the cuttings. The drilling fluid is commonly known as "mud," reflecting its origin in the murky mixture bailed from early wells. Rotary drilling technology continued to improve in the 20th century and almost entirely supplanted percussion drilling in the petroleum industry after the Second World War.

In the 19th century, steam engines, walking beams, and improvements in pole drilling led to what became widely known as the Canadian drilling system. A leader in the development of this technology was William McGarvey, who shipped strings of Canadian pole tools to Germany in 1881 and two years later to Galicia (a territory now divided between Poland and Ukraine). In Galicia, the Canadian drilling rig was further developed by McGarvey, who patented a number of improvements. The system "became the principal type of drilling equipment used to develop the oilfields of Europe in the late 1880s and early 1900s," according to Brantly. "The Galician Canadian pole-tool rigs," he writes, were "designed for deep well drilling," used "almost exclusively" in the Polish oilfields and widely in all other Western European oilfields until the Second World War, and "were the basic design" of the Russian drilling rigs used in the big Baku oilfields by the Caspian Sea. "They all used walking beams and drill rods until replaced by hydraulic rotary tools beginning about 1920." Wooden rods were used at first in the European drilling, followed by iron and steel rods for deeper drilling.

Foreign adventures

There were four of them—Malcom Scott, Joshua Port, William Covert, and Edward Cook—the first of hundreds of Petrolia men who drilled wells, produced oil and built and operated pipelines and refineries in foreign fields. These first four were off to the Island of Java in the Dutch East Indies (now Indonesia). Like those who followed, they brought with them the talents, tools, and technology honed in the oilfields of Enniskillen. It was winter, late in 1873, and the four hard oilers, as such men later called themselves, were escorted to Petrolia's railway station by a parade. At the station, the band played and the crowd sang "Will Ye No Come Back Again?"—the emotional song highlanders had sung to Charles Stewart, "Bonnie Prince Charlie," as he fled Scotland after the failed uprising of 1745.*

These first four hard oilers were recruited by European companies who failed to find the skilled workers they sought in the busy American oilfields, but soon learned they could do no better than in Petrolia. The Petrolia men usually spent two- or three-year stints in the foreign fields, earning big money, sending much

* The crowd on a dock in Vancouver in early 1939 sang the same song to King George and Scottish Queen Elizabeth as they departed from a cross-Canada royal tour under the looming clouds of the impending Second World War.

CANADIAN DRILLING RIG
Diagram of the pole-tool drilling rig that drilled most of Ontario's early oil and gas wells, and most of those in Europe until about 1920.
Credit: *Courtesy Fairbank Oil Properties*

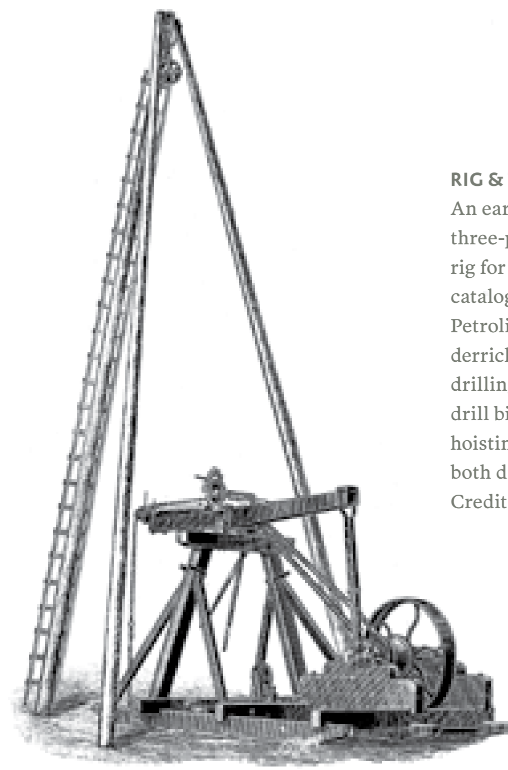
of it home together with letters of life and adventure in far-away and often exotic lands. Some returned with brides from foreign lands; some married and made new homes in Europe. Some wives and families left their homes in Petrolia to make new homes with their husbands in the European oilfields. The experiences of hard oilers and their families made Petrolia Canada's most cosmopolitan small town.

In the period of cutthroat competition that prevailed in the oil industry before the First World War, many British-based companies, and particularly the Royal Dutch/Shell* group preferred drillers and oilfield workers from the British Empire. They feared that American workers might leak confidential information to Rockefeller's Standard Oil.

"No other centre on the American continent has contributed so many expert drillers and oil operators to foreign countries for the production and development of the industry," Victor Ross claimed in his 1917 *Petroleum in Canada.* But it was no picnic: the work was hard, "often dangerous, and several Hard Oilers perished," Gary May writes in *Hard Oiler!* They "fought yellow fever and malaria in the tropics' intense heat and laboured under scorching sun among the shifting sands of the Middle East. Huge pieces of equipment sometimes fell on them... Wild beasts roamed around the oil work, and reptiles abounded." In Europe they were caught and some killed in the chaotic crossfire of the First World War; they dodged German submarines, hid from hostile troops and marauding bandits in the Carpathian Mountains of Central Europe, and in the Middle East "they hid from hostile Arabs in the mountains of Persia [now Iran]."

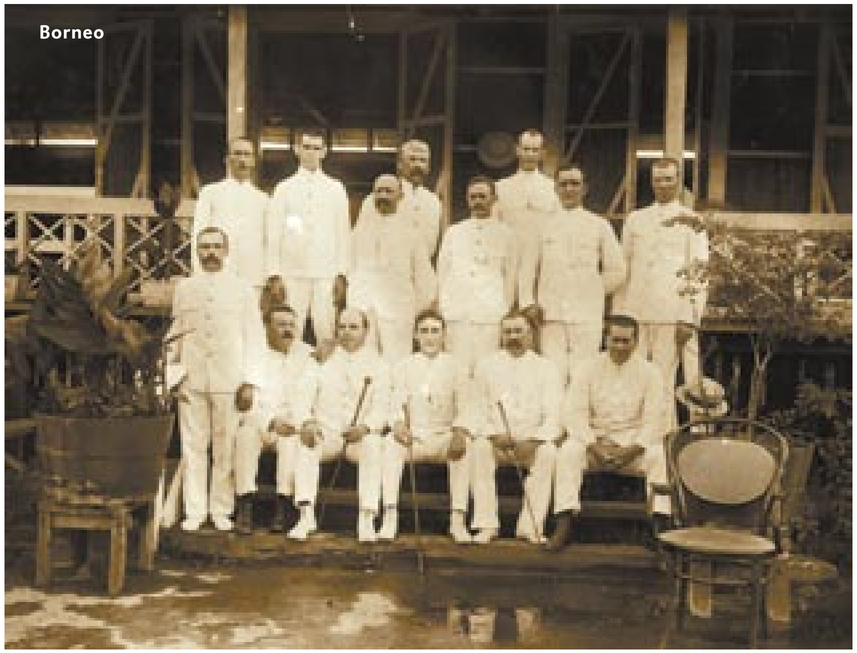
* Two of Europe's leading petroleum companies—Marcus Samuels' British Company, Shell Transport and Trading Company Ltd., and the Royal Dutch Petroleum Company of the Netherlands—formed a joint venture, Asiatic Petroleum Company Limited, in 1903, and the two companies formally amalgamated in 1907. Shell continues to hold 40 per cent interest in the Royal Dutch/Shell Group, and Royal Dutch 60 per cent.

Their greatest achievements were in the largest oil-producing areas of Europe—Galicia, Romania, and Russia—where Canadian drilling rigs, skills, and supervision dominated for more than 30 years. Leading the Petrolians in Europe to outstanding success, wealth, and final ruin in the ravages of war, was William H. McGarvey.



RIG & TRIPOD
An early steam-powered drilling rig and three-pole derrick, described as "drilling rig for wells 300 ft. deep." From the catalogue of the Oil Well Supply Company, Petrolia, circa 1900. The three-pole derricks were used to periodically hoist the drilling tools out of the hole to change the drill bit and bail out ground-up rock, or for hoisting other downhole equipment during both drilling and producing operations.
Credit: *Courtesy Fairbank Oil Properties*

AUSTRALIA and BORNEO
Hard Oilers from Petrolia, at work and play in foreign fields; at a drilling rig in Australia, circa 1905, and at what appears to be a country club in Borneo (an island in the South China Sea) in 1907. Petrolia is said to have sent more oilfield workers to foreign lands than any other town or city in North America.
Credit: *Lambton County Museums (PE 001 058 010, Australia; FD 003 007 001, Borneo)*



WILLIAM McGARVEY
William H. McGarvey, a Petrolia oil producer and former mayor of Petrolia, founded one of Europe's largest oil firms, based in Galicia (Poland). His empire of oil wells, pipelines, and refineries was destroyed in the flames of the First World War.
Credit: *Lambton County Museums*

William McGarvey's empire

Born in Huntingdon, Quebec, William McGarvey was 12 when the family (including younger brothers James and Albert) moved to the village of Wyoming, Ontario, in 1855. The senior McGarvey opened a general store that prospered a few years later with the arrival of the railway and the development of the Oil Springs and Petrolia fields. The ambitious William McGarvey soon moved to Petrolia where he opened his own Mammoth Store, became Petrolia's first reeve, mayor, and warden of the County, drilled 16 oil wells, and was credited with further development of the distinctive Canadian pole-tool drilling rigs. He also married Helena Jane Weslowski, the Michigan-raised daughter of a Polish émigré who had been expelled by the Russians for anti-government activity. That was McGarvey's first link with Galicia.

McGarvey was drawn to Europe in 1881 by John Bergheim, a British engineer who had come to Petrolia in search of a crew to drill an exploratory well at an oil prospect in Germany. Like most wildcats, the German well was a dry hole. However, there was another prospect, in Galicia, near the Carpathian Mountains. With the grand official name of "The Kingdom of Galicia and Lodomeia, and the Grand Duchy of Krakau with the Duchies of Auschwitz and Zator," Galicia was a province of the Austro-Hungarian Empire, ruled from Vienna by Emperor Franz Joseph. It was a stew pot of nationalities—some seven million Poles, Germans, Hungarians, Czechs, Jews, Armenians, Ruthenians (Ukrainians), and others, of whom three-quarters were peasants. Until somewhat emancipated by Franz Joseph, the peasants were under such servitude to 19,000 families of the nobility that they could not even marry without the permission of their lords.

BOBRKA FIELD
Early development of Poland's Bobrka field. The field has been producing oil since 1854. It was acquired by William McGarvey in 1893 and later transferred to his Galician-Carpathian Petroleum Company.
Credit: *The history of the Bobrka Oil Field, EIOBA group, wwweioba.com/tbobrka-19k.*

The first Galician well apparently failed for want of an adequate pump to lift the oil, but it led to the formation of Bergheim & McGarvey Company, holders of substantial prospective oil lands. Petrolia toolpusher William McCutcheon brought in the first big oil well on the Bergheim & McGarvey holdings near Krakow, and the new company was off and running. Eighty-foot-tall enclosed wooden derricks, with windows and central steam heating to protect workers from winter winds and snows, soon dotted the countryside.

A year after he left Petrolia, McGarvey was joined in Vienna by Helena and their children. William's younger brothers Albert and James soon followed, apparently working first in Galicia for Bergheim & McGarvey before developing oilfields in Romania, then part of the Russian Empire, and in Russia itself at Grozny, where they were in charge of the North Caucasian Oil Company.

By the fall of 1895, McGarvey was wealthy enough to host one of Vienna's grandest weddings when his daughter Mamie married German count Ebert Friedrich Alexander Joseph Edward Graf von Zeppelin, nephew of the inventor of the German airship. Ebert also served as officer in the German army, and 20 years later fought British and Canadian soldiers in the First World War. The McGarveys by now spent more time in Vienna attending fancy balls and glittering social events, than they did at their castle in Gorlice, Galicia (Poland today). At the wedding, Canadian drillers rubbed elbows with European royalty. Gifts ranged from diamond bracelets and Persian carpets to carriages and horses, while McGarvey gave his daughter and son-in-law a 700-acre estate and a castle. Mamie and the count divorced eight years before the start of the First World War, but the McGarveys' second daughter, Nellie, remained married to an Austrian judge who also fought the Allied forces in the war.

By 1912, McGarvey's oil empire, wealth, and personal fortunes seem to have reached their peak. The Galician-Carpathian Petroleum Company, successor to Bergheim & McGarvey, was one of Europe's larger oil companies. It employed 2,000 workers—supervised by Canadians—to operate hundreds of Galician oil wells along with associated pipelines and refineries. The company's oil refinery in Italy, at Trieste on the Adriatic Sea, was Europe's largest outside of Russia, and it shipped products to world markets. A drilling subsidiary operated rigs in Mexico, Cuba, Nigeria, and elsewhere. As chairman, McGarvey now managed the company's affairs from Vienna, while management of the field work had been taken over by Bergheim.

Masked by wealth and accomplishments, McGarvey's first pangs of tragedy had already been felt. McGarvey by now had been widowed 15 years. In 1911, his youngest brother, James, together with his wife and family, were murdered by armed bandits in their home in Grozny, Russia. The following year, Bergheim, McGarvey's partner and close friend, was killed in a car accident in London.

The cauldron of politics was also brewing the final disaster. In the first years of the 20th century, McGarvey's allegiances were tangled in the different camps of the fluid and ever-changing alliances of major European powers—Austria-Hungry, Germany, Russia, France, Italy, and Britain—camps that were often blindly and unknowingly stumbling toward the most catastrophic war the world had yet suffered. Business, social, and family ties bound him to the Austro-Hungarian Empire; old loyalties tied him to the British. Unwittingly, he had been building a potential fuel supply for the armies Britain would soon fight, while at the same time he had worked as an advisor for the British Admiralty in the conversion of warships from coal to oil and in the search for oil on British soil.

GALICIAN BLAZE
One of the fires that destroyed the oil wells and refineries of Galicia during the First World War, this one reportedly burned for 18 days. It might have been one of the fires that destroyed the oil empire of W.H. McGarvey, the Canadian who developed one of Europe's largest oil enterprises prior to the First World War.
Credit: *Michael Duffy, www.firstworldwar.com*

When the war came that summer of 1914, the Russian army swept across Galicia before being pushed back by the resurgent armies of Germany and Austria-Hungary. In their retreat, the Russians set fire to the oil wells and blew up the refineries of Galicia, demolishing McGarvey's oil properties. In Vienna, the man who had once been honoured by Emperor Franz Joseph at a special ceremony in the Imperial Palace for his role in establishing the empire's petroleum industry, was now under house surveillance by suspicious Austrian authorities. In November 1914, on his 71st birthday, he suffered a stroke and died. It was more than the end of a big petroleum enterprise. It was the end of an era.

Eugene Coste ignites the natural gas industry

The geological theory of Eugene Marius Coste might have been all wrong, but the results were all right. They led to the establishment of Canada's natural gas industry with the discovery of Ontario's first gas fields in the southwest corner of the province that had given birth to the nation's oil industry. Even if he was chasing a wrong idea, Coste was clearly the father of Canada's natural gas industry.

Most geologists now agree that crude oil and natural gas have come from the decomposition of plant and animal life deposited millions of years ago in sediments on the bottoms of ancient seas and lakes. Coste held that the source of oil and gas is inorganic,* originating deep in the bowels of the earth, from the

* Among those who have kept alive the inorganic theory of oil and gas origin is veteran Calgary petroleum geologist C. Warren Hunt. "What they've been teaching us in school about oil coming from fossils is wrong," Hunt declared in 1993. Hunt and other believers, including many in Russia, hold that the claimed inorganic origin would result in the discovery of substantially larger world oil and gas reserves. But a deep well drilled in 2002 into Precambrian rock in search of an inorganic source of the bitumen in Alberta's Athabasca oilsands failed to find any significant oil or gas. (See *"Oil Without End?"* Fortune magazine, February 17, 2003).

EUGENE COSTE
Eugene Marius Coste (1859-1940), founder of Canada's natural gas industry, discovered Ontario's first gas fields and later led the discovery and development of large gas fields in southern Alberta. Credit: *Glenbow Museum, NA1446-24*

Coste's first two exploratory wells were spectacular gas discoveries, launching the industry that was to provide Ontario's natural gas supplies for the next half century.

same source as volcanoes, and that the hydrocarbons migrated through fissures in Precambrian rocks to accumulate in those sedimentary deposits.

The Coste saga, at its outset, bounced back and forth between France and Canada. It started with Napoleon Alexandre Coste, the son of a well-to-do Marseilles family, who was sent to launch a naval career aboard a French freighter plying between Europe and the Americas in the hope that he might someday even become an admiral. He was somehow diverted—historian Victor Lauriston suggests he may have been shanghaied[14]—to a Canadian schooner plying the St. Lawrence and the Great Lakes. Treatment aboard the schooner was said to be so harsh that he escaped by jumping into the Detroit River and swimming ashore at Amherstburg, some 6 miles south and a little west of Windsor. Here he was sheltered by a French-Canadian farm family, was hired as a local school teacher, married the farmer's daughter, acquired British citizenship, established a career in municipal politics and business, and sired three sons and a daughter (a fourth son was later born in France). The second son was Eugene.

In 1863, within two decades of his arrival in Canada, Napoleon returned to France with his family. Eugene was four. Twenty years later, Eugene graduated from the Ecole National Superieure des Mines as a mining engineer. It was from the French geologists there that Eugene learned about the inorganic theory of oil and gas, a theory he propounded for the rest of his life in innumerable papers and lectures with titles such as "The Volcanic Origin of Natural Gas and Petroleum."

While Eugene was being schooled, Napoleon was busy making money in Egypt, first as a ship chandler then as a contractor in construction of the Suez Canal. He piloted the first ship through the canal. He also made enough money that he was able to return to Ontario 19 years after he left to build a mansion on a bank of the Detroit River. The bricks were imported from France, and the mansion was stuffed with objects imported from England and the Far East. He resumed his career in municipal politics, serving 18 years as reeve of the town of Malden, and set his sights on election to the Ontario legislature. To further his political goal, he published two newspapers, edited by two of his sons, but never managed to win his coveted seat.

As soon as he graduated from the Ecole National Superieure des Mines, Eugene too returned to Canada where he joined the Geological Survey of Canada. No sooner was he promoted to the position of mining engineer than he left the GSC to don the mantle of promoter and wildcatter.

Whether Coste, like most wildcatters, was looking for oil or whether he had natural gas on his mind, is not known. In any event, his first two exploratory wells were spectacular gas discoveries, launching the industry that was to provide Ontario's natural gas supplies for the next half century.

Gas, including both the natural product and that manufactured from coal, was not entirely new to Ontario. Almost a century before Coste began looking for oil and gas in Ontario, a letter dated November 10, 1794, in the archive files of Lieutenant Governor John Graves Simcoe, reported a spring above Niagara Falls that was "emitting gas, or an inflammable air, which when confined in a pipe, and a flame applied to it, will boil the water of a teakettle in 15 minutes. Whether this may hereafter be applied by machinery to useful purposes, time will determine."[15]

Not far away, on the southeast shore of Lake Erie, William Hart dug a well in 1821 and tapped into a natural gas reservoir (part of the same sedimentary

One enterprising farmer reportedly collected gas for his house in a pig's bladder.

basin as the vent at Niagara Falls) near the town of Fredonia, New York. Gas from Hart's well was carried through wood pipes and by 1825 supplied lighting to two stores, two shops, and a grist mill. The Fredonia Gas Light Company, incorporated in 1858, was North America's first natural gas company.

Some small volumes of natural gas inevitably found in the search for oil were put to limited use, in some cases fuelling the steam engine of a drilling rig or an oilfield pumping system, supplying fuel for light and sometimes heat in a few farm houses, and at least one hotel. One enterprising farmer reportedly collected gas for his house in a pig's bladder.[16] These very limited uses aside, efforts to develop natural gas production on a commercial basis had usually failed after a fire destroyed the drilling rig or production facilities.

On the other hand, manufactured gas—also known as town gas or coal gas—was a well-established business. Canada's first coal gas works was established in Montreal in 1836, followed by Toronto four years later. In the next half century, coal gas works were established in such Ontario centres as Hamilton, Brockville, Ottawa, London, Peterborough, Chatham, Windsor, and Port Colborne. Coal gas was the chosen fuel for lighting until about 1900 when electricity became available, after which the manufactured gas was used increasingly for heating. Natural gas, containing much more energy per cubic foot, would be a far cheaper source of fuel, if an adequate supply could be found and developed.

This was the situation that confronted Eugene Coste in 1888 when he set out to test a geological theory. He reasoned that a supposed anticline that had yielded oil and gas pools in Ohio might extend across Lake Erie with the prospect of such pools in Ontario. He and his brother Dennis, one of this father's newspaper editors and later a gas utility executive, organized a syndicate to acquire petroleum leases and drill a test hole in Gosfield Township, the township in which Eugene had been born. On January 23, 1889, Coste No. 1 well ushered in Ontario's first prolific natural gas field, the Essex field near the tip of Ontario's southwest peninsula. From a depth of 1,031 feet, the well flowed gas at a reported rate of 10 million cubic feet per day, in energy content equivalent to about 1,700 barrels of oil per day. That probably exceeded Canada's total oil consumption of both kerosene and lubricating oils in that year.* Ah, if only those flow rates could be maintained.

Another syndicate was formed, and in August, Coste discovered Ontario's second natural gas field, the Bertie-Humberstone field, some 185 miles east of the Essex field and about 15 miles southwest of Niagara Falls, with the discovery well blowing gas at an initial rate of 1.7 million cubic feet per day.

The supply of natural gas from these two fields, and others that soon followed as wildcatters rushed in, was deemed to be virtually inexhaustible. As with every other new oil or gas field in this era, wells were drilled as fast as possible and the gas was produced as quickly as buyers could be found.

To transport, distribute, and sell gas from their two fields, the Coste interests organized Canada's first two gas utilities—the Ontario Natural Gas Company to market gas from the Essex field and the Provincial Natural Gas and Fuel Company of Ontario to handle production from the Bertie-Humberstone field. But where to find markets big enough to handle the potential output from these two "inexhaustible" supply sources? Ontario's major centres, even Toronto, were too distant to be economically connected by the cast-iron pipelines of that era. The economic markets in Canada were smaller centres closer to the fields, but these

* The first reported data on Canadian oil consumption were for 1899, 10 years later, when Canadians used 817,000 barrels of oil, or some 2,200 barrels per day.

Everything went swimmingly until it became apparent that the supposedly inexhaustible supply of natural gas was rapidly being exhausted.

were considered too small, and in the case of Windsor near the Essex field, the local coal gas utility was not about to open its franchise to this new competitor.

Bigger markets beckoned nearby in the United States. A scant two years after discovery of the Niagara area gas field, Coste's Provincial Natural Gas had laid three small diameter pipelines across the Niagara River to supply consumers in Buffalo, New York. It was the first export of Canadian natural gas to the United States. Four years later, in 1895, a new gas utility backed by Coste and other gas producers laid a pipeline across the Detroit River to supply natural gas to Detroit consumers. Not only that, but there was an idle pipeline that had once supplied Detroit with natural gas from Toledo, Ohio, and the Essex field was soon supplying gas to both American cities.

Everything went swimmingly until it became apparent that the supposedly inexhaustible supply of natural gas was rapidly being exhausted. Although the gas at first flowed abundantly from wells in the new fields, especially Essex, it was being drawn from small accumulations and had no staying power. The productive area of the Essex field was only five square miles and the pay zone was barely a yard. Small new gas pools that were being brought in could not offset rapidly declining production from Ontario's first two natural gas fields and meet the needs not only of Canadian but also American consumers.

In 1901, to protect the needs of Canadian consumers, the federal government stepped in to shut down the pipeline across the Detroit River supplying Detroit and Toledo. Two years later, Ottawa shut down the pipeline across the Niagara River to Buffalo. Too late. By 1904, just 12 years after sustained production began, the Essex field was depleted, and even Canadian consumers were cut off from their natural gas supplies.

A more formal arrangement to control Canadian energy exports—including electricity, oil, and natural gas—was provided in a bill introduced in Parliament by Justice Minister Bristol Ayleworth in the federal administration of Wilfrid Laurier. Subsequently enacted as the *Electricity and Fluids Export Act (1907)* the legislation specifically included natural gas. All exports were to be authorized by licences, and the act gave the government sweeping powers to set the terms, including volumes, duration, prices, and export taxes. It even authorized Ottawa to revoke licences.[17] This legislation would remain the federal government's instrument for control of energy export for more than four decades.

Ottawa clearly had the constitutional authority to control the international trade of any Canadian product, including the imposition and collection of export taxes. But the thought that a Liberal government in Ottawa might tax any export sales of Ontario's natural gas did not sit well with James Whitney, Ontario's Conservative premier. He devised a plan that he thought would get around Ottawa's constitutional jurisdiction, and collect any such revenue for the Ontario government. Shortly after the Electricity and Fluids Exportation Act was introduced in the House of Commons, Whitney's government introduced a bill in the provincial legislature to tax revenue from the sales of Ontario mines and minerals. In debate on the measure, Whitney outlined how he intended to get around Ottawa's power: While the province could not impose an export duty, "the plan had been evolved of taxing all gas produced and making a rebate on that portion used in the province." This would have the same effect as an export duty.[18]

It was possibly the first federal-provincial conflict over control and revenue sharing of Canadian energy resources, a tussle that has gone on ever since.

Most of the natural gas wells in Ontario's southwest peninsula were drilled on land, but some 550 wells now produce from waters on the Canadian side of Lake Erie.

Coste not only established Ontario's natural gas industry, but did much to help establish Alberta's. In 1893, drilling for water near Medicine Hat for its locomotives, the Canadian Pacific Railway accidentally stumbled on one of Canada's largest natural gas fields. In 1906, the CPR hired Coste to help find more Alberta natural gas. His successes included discovery of the large natural gas fields at Bow Island, which would eventually supply Lethbridge and Calgary through one of the first long-distance natural gas pipelines.

Coste must have been busy travelling back and forth between Ontario and Alberta on his CPR pass. In the same year he was hired by the CPR to help find more Alberta gas, Coste and his brother Dennis organized yet another Ontario gas utility, the Volcanic Oil and Gas Co., which four years later merged with other firms to form Union Gas, the utility that still serves gas consumers throughout Ontario's southwest peninsula. (Union Gas is now owned by Spectra Energy of Houston.)

On the heels of Coste's first two Ontario discoveries, natural gas was found and produced at thousands of wells in scores of relatively small and shallow gas pools. At times the new gas fields provided enough supply to meet the needs of communities and consumers from Niagara Falls to Windsor. At times there were shortages. Elsewhere throughout Ontario, in centres such as Toronto, Kingston, Ottawa, and others, consumers continued to be served by gas manufactured from coal.

By the end of the Second World War, it was apparent that if most of Ontario was to be served with cleaner and lower-cost natural gas, the supply would have to come from either Texas or Alberta. Canada's first two large, long-distance gas pipelines not only solved the Ontario problem but provided natural gas throughout most of the country. First was the 1957 completion of the Westcoast Transmission line that supplied northern British Columbia natural gas throughout most of the province. The Trans-Canada pipeline that delivered Alberta natural gas as far east as Montreal was completed the following year. These lines sounded the death-knell of the coal gas industry.

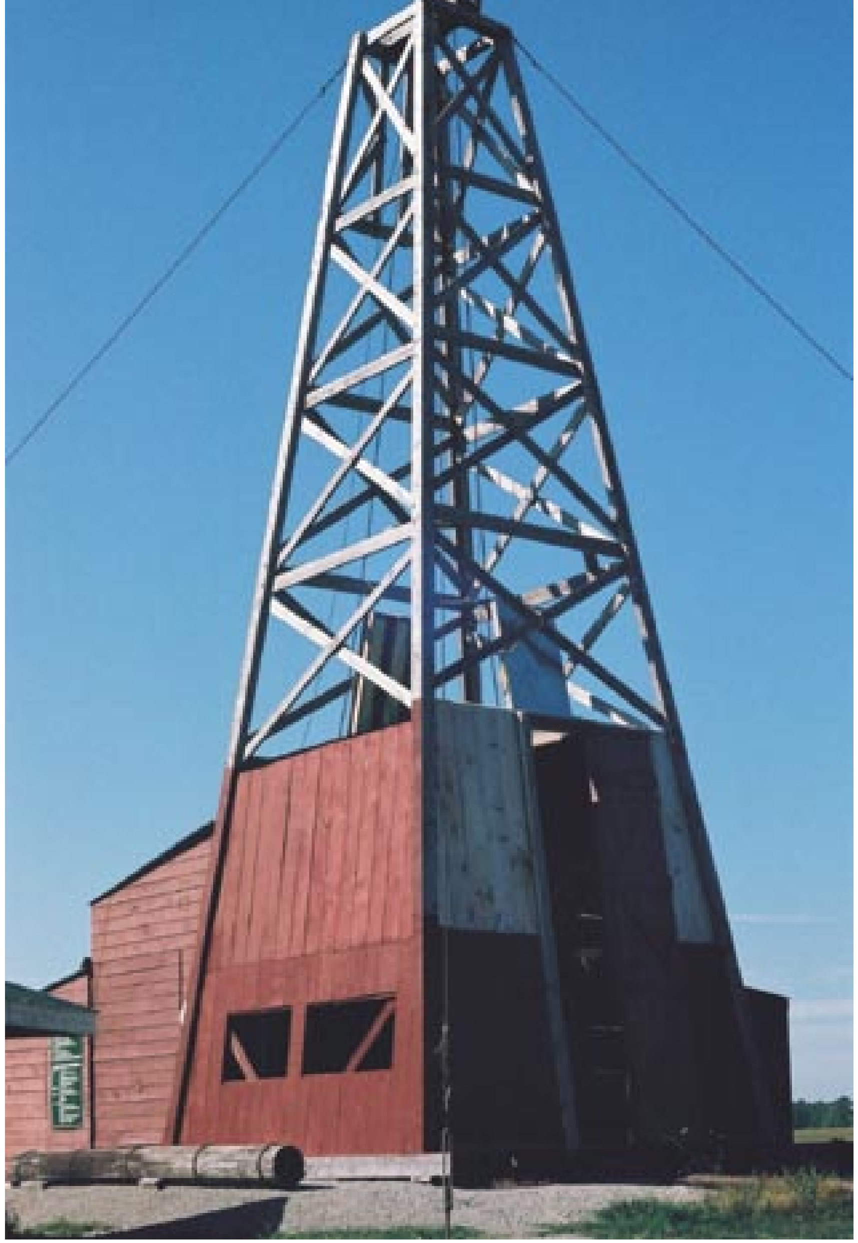
Drilling for natural gas

Some of Ontario's earliest natural gas wells were drilled with Canadian pole-tool rigs, with 50-foot joined sections of white ash poles used to pound down the percussion drill. In later rigs the wooden poles were replaced by steel cables. For the last half-century or so, modern rotary rigs have been used.

One of the last Canadian-type drilling rigs to drill Ontario natural gas wells, and perhaps some oil wells, was built by the Oilwell Supply Company in Petrolia in 1896. It worked until 1960, when it was left abandoned. In 1996, this heavy-timbered, steam-powered rig was restored and moved to the Canadian Drilling Rig Museum at Rainham Centre, 15 miles south of Hamilton. Here, the rig and other early natural gas drilling, production, and marketing equipment can be examined by visitors.

Most of the natural gas wells in Ontario's southwest peninsula were drilled on land, but some 550 wells now produce from waters on the Canadian side of Lake Erie. The first offshore tests were drilled on causeways of piled rock and rubble, extending a few yards from shore in water less than about two yards deep. One was completed on May 15, 1913, historian Victor Lauriston reports,[19] while consulting geologist Robert Cochrane believes the first might have been drilled about 1895.[20] Starting in the 1960s, drilling was extended to deeper waters,

RAINHAM RIG
Built in 1896, abandoned in 1960, and restored in 1996, this is one of the last Canadian-type drilling rigs.
Credit: *Earle Gray*



though generally less than 30 yards. As described by the Canadian Centre for Energy Information in *Our Petroleum Challenge* (2004):

> Ships and barges are used during ice-free months to drill wells and service the wellheads and pipelines on the lake floor. A jack-up rig, originally used for drilling, has been converted into a seasonal field compressor to boost pressure in a portion of the 1,500 kilometres of pipeline carrying natural gas to onshore processing facilities.[21]

Environmental regulations prohibit crude oil production from under the Great Lakes, but directional and horizontal wells drilled from land tap oil reservoirs several miles out under Lake Erie.

Ontario's petroleum region is one of the world's most extensively drilled. Yet explorers keep looking for more new crude oil and natural gas pools—and finding them. In the five-year period to 2005, they found new gas pools expected to yield nearly 28 billion cubic feet of natural gas[22] and 102 million cubic feet (18 million barrels) of crude oil.[23] At 21st century wellhead prices, these new pools will generate much more revenue than the industry earned in its turbulent early years. Important as these resources might be, though, indigenous production supplies only a tiny fraction of Ontario's needs, about two per cent in the case of natural gas.

Ontario today also plays a significant role as one of North America's natural gas storage and trading hubs. The world's first underground storage of natural gas was carried out on an experimental basis in 1915 by Union Gas Company in Welland County. Some 30 such storage facilities in depleted Ontario oil and gas fields now hold more than $2 billion worth of natural gas; this gas is stored during low-demand summer months and withdrawn in peak winter demand periods, avoiding billions of dollars in infrastructure otherwise needed for long-distance pipelines from the West. The underground storage serves consumers in Ontario, Quebec, and the eastern United States. Underground gas storage is also used like a warehouse for energy traders, with North America's first natural gas trading "hub" completed near Sarnia in 1982.

CHAPTER 5

FUELLING THE HORSELESS CARRIAGE

In the final few years of the 19th century, smart money had every reason to bet on the demise of Canada's petroleum industry. No new oilfields had been found for three decades, production was declining, and so was demand as the electric light bulb began replacing lamp oil. In all of Canada, the Imperial oil plant at Sarnia was the only petroleum refinery still operating.

PUMPING OIL IN 1903
Pumping oil in the Petrolia field, 1903. Horses continued to be used in the Petrolia and Oil Springs fields until the 1950s, because they were needed for the three-pole derricks.
Credit: *Archives of Ontario, 10003307*

Coal was the main source of energy in Canada and globally. No one seemed to think "King Coal" could ever be dethroned. English economist William Stanley Jevons wrote of coal:

> It is the material energy of the country, the universal aid, the factor in everything we do. With coal, almost any feat is possible or easy; without it we are thrown into the laborious poverty of early times.[1]

That was the experience of England. In Canada, wood was also an important source of energy. Wood heated most homes, fired most cook stoves and ovens, and still fuelled many steam engines. Between them, coal and wood supplied all but a very small portion of the energy used by Canadians. In 1901, coal alone supplied Canadians with about 60 times as much energy as oil.*

During the century that followed, crude oil and its allied product, natural gas, transformed life in industrial societies. A dynamic Canadian oil industry even met the challenge of producing fuels from the Alberta oilsands, one of the world's largest known petroleum resources.

Now, as the 21st century dawns, Canada is on a track that could make it the Western Hemisphere's most important energy producer.† And, though Ontario's oilfields now yield only a trickle of oil compared to the flood from Alberta, Sarnia remains a major centre of oil refining and related petrochemical industries.

* Reported energy consumption in 1901 included 631,000 barrels of oil and 9,776,000 tons of coal. One short ton of coal is taken as the energy equivalent of 4.5 barrels of oil, although this can vary considerably, depending on the type of coal and oil. Unless otherwise stated, all energy statistics in this chapter are taken from *Historical Statistics of Canada* (Ottawa: Statistics Canada, 1983).

† In 2006, according to the BP Statistical Review of World Energy 2007, both the United States and Mexico produced more crude oil than Canada—slightly more in Mexico and about twice as much in the United States–but production was stable or declining in those countries, while Canada's production was growing steadily as more oilsands projects came on stream. The United States already imported more than half of its crude oil requirements in 2006, and Canada was the largest single supplier. By 2030, if rapid oilsands expansion continues, Canada could replace the United States as the hemisphere's largest crude oil producer. Canada also exports natural gas, electricity, and coal.

The Age of Energy

The internal combustion engine and the automobile initiated the change in the petroleum industry's prospects from doom to boom. Other developments, especially aircraft and petrochemicals, would follow and add to the growth in demand. After a dry spell that lasted decades, Canadians found and developed vast petroleum wealth to meet this demand.

Petroleum historians have described the historic shift in the petroleum industry's circumstances as a change from "the Age of Illumination" to "the Age of Energy."[2] The change spanned decades. During that time, no one could foresee how it would all work out. At first, there was little to indicate that oil would become the world's principal source of energy. However, it should have been evident that a concentrated, easily transported, versatile form of energy would find wide usage.

Consider the evolution of the electric light bulb that trimmed the wicks of the world's "coal oil" lamps. It took 77 years from the time that English scientist Humphrey Davy obtained a patent for an electrical incandescent light bulb until the first practical one was produced by Thomas Edison. During that long period, patents were issued for more than 20 different electric light designs, none of which was commercially successful, until Edison's. Among the patented light bulbs was the 1874 Woodward and Evans Light developed by Toronto medical electrician Henry Woodward and his colleague Matthew Evans. Although the Woodward Light never shone in the commercial market, the potential of the

OIL WAGON
A horse-drawn Imperial Oil delivery wagon at Winnipeg, circa 1890. Soon after it was founded in 1880, Imperial Oil began delivering kerosene across the western prairies in wooden barrels on creaking Red River carts.
Credit: *Imperial Oil Collection, Glenbow Archives*

OIL TRUCK
Imperial Oil began replacing its horse-drawn oil wagons with motor tanks about 1912 when this, one of the company's first, appeared on the scene.
Credit: *Imperial Oil Collection, Glenbow Archives*

Woodward and Evans concept so impressed Thomas Edison that he bought the Canadian and U.S. patents for US$5,000. In the late nineteenth century, Woodward and Evans could each have bought luxury houses with that amount of money. Five years later, Edison secured patents for the bulb that, with further improvements, would dominate lighting for more than a century.

While the development of a glass bulb with a glowing wire threatened the existence of the kerosene-oriented petroleum industry, the development of the gasoline-powered horseless carriage soon came to the rescue. Like the electric light, however, the automobile emerged gradually from decades of scientists' discoveries and mechanics' tinkering, and an introduction fraught with uncertainty. Most people initially viewed the motor car as a useless plaything, a nuisance, or a danger. The first practical motor vehicle powered by a gasoline-fuelled internal combustion engine was produced in Germany by Karl Benz in 1885, but it was 13 years later before the first one arrived in Canada—a one-cylinder machine imported from Cleveland, Ohio by Hamilton textile manufacturer John Moodie.

By 1903, there were 178 automobiles in Canada. Mostly they were greeted with derision, alarm, and hostility. Farmers in particular—and there were more Canadians on farms than in cities—were upset. The noisy machines spooked their horses and caused runaways. "Heavy cars, driven at express speed," were ruining country roads, paid for by farmers to haul their produce to market, said Toronto's *Weekly Sun,* while "fear of meeting racing autos" was said to have excluded tens of thousands of farmers' wives and daughters from travelling on "practically all the good country roads."[3] The *Edmonton Bulletin* urged readers to tie their horses securely to hitching posts since the city's growing number of automobiles was certain to "increase... the number of runaway horses." It called for a city bylaw "regulating the speed of horseless vehicles," curbing those who "shoot through space, scattering chickens and children with a bugle-blast, and leaving only a trailing odor of gasolene [sic] along the deserted streets."[4]

The Globe in Toronto blamed the "animal adversion" greeting the machines on a "lack of consideration on the part of some automobilists who are not happy unless they are going at top speed," which was then less than 15 or 20 miles an hour.[5] The London, Ontario, *Free Press* blamed automobiles as one reason for an alleged decline in physical exercise.[6] As late as 1906, five of six men questioned by *Maclean's* magazine in a survey—no one seems to have thought of asking women—preferred the horse-drawn carriage.

Canada's 178 registered motor vehicles in 1903 were apparently not enough to arrest the decline in oil demand from its peak of 1899. Gasoline-powered motor vehicles, however, were slowly improved, and early in the 20th century they overcame competition from electric- and steam-powered models. Sales increased, and the demand for oil increased in lockstep. A few figures tell the story:

Motor Vehicles and Oil Consumption

	Number of motor vehicles	**Annual oil consumption** (thousands of barrels)
1899	handful	817
1903	178	548
1910	9,158	1,848
1914	74,246	5,297
1920	408,790	8,689
1930	1,232,489	29,736
2007*	26,000,000	840,000

**estimate*

OIL GUSHER IN THE 1930s
Explosive charges were still being used in the 1930s to stimulate oil production at Petrolia wells, triggering oil gushes such as this. Credit: *Oil, Gas and Salt Resource Centre, London, Ontario*

Petroleum refining

Relative to the technology built into today's machines, motor vehicle improvements in the first two decades of the 20th century might not seem that impressive. As Imperial Oil chemist and refining expert G.A. Purdy describes it:

> During the early 1920s motorists expected trouble and inefficiency from their engines because that was customary. Speeds of twenty miles an hour were customary, every hill was a challenge and it was a foolhardy motorist who didn't have a tow rope. Carburetors were expected to choke with gum and a carboned engine was commonplace. Knocking was usual.[7]

The problems were not just with the vehicles, but with the gasoline supplied by petroleum refineries. Refiners had to scramble to keep up with the market's rapidly changing demands. They had to process rapidly growing volumes of crude oil, and also produce a different mix of products. Naphtha or gasoline had been an unwanted by-product, usually burned or discarded during production of kerosene for lamp fuel, but now gasoline became the principal commodity while demand for lamp fuel diminished. The quality of gasoline had to improve to prevent clogged carburetors and engines stalled by carbon deposits. The refiners also had to produce better lubricants.

Refineries today still use atmospheric distillation—the same basic method employed at Oil Springs and Petrolia 150 years ago to extract kerosene from crude oil—as a key step in separating the different types of hydrocarbons in crude oil. But refining processes had to be extended far beyond simple distillation to achieve cleaner fuels, higher octane, and a wider range of fuels, lubricants, asphalt, waxes, petrochemical feedstocks, and other products. New ways

OIL REFINING IN THE 1920S AND 1950S
The Imperial Oil Refinary in Sarnia evolved considerably from the 1920s (photo is from 1928) to the 1950s.
Credit: *Imperial Oil Collection, Glenbow Museum*

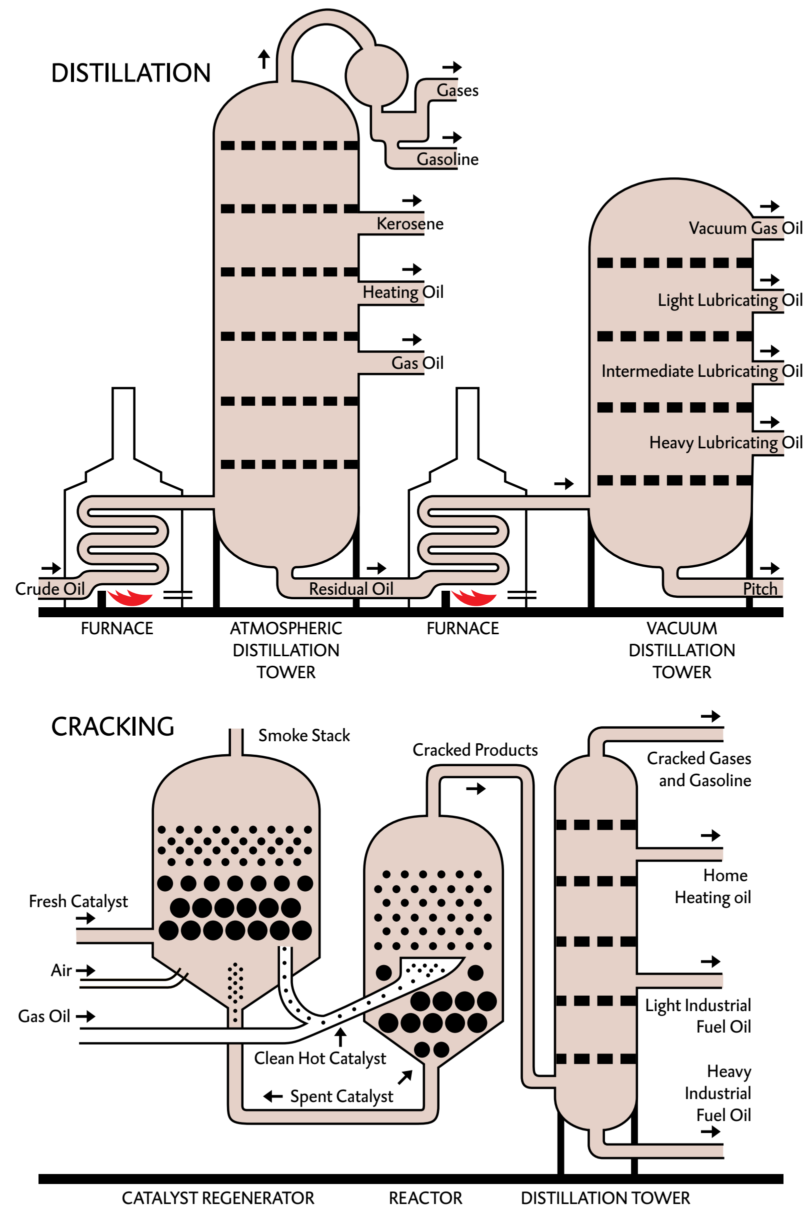
were found to remove sulphur and metals and to manipulate the hydrocarbon molecules that make up crude oil. Large ones were cracked into smaller ones, using heat, pressure, and catalysts to create lighter, more volatile fuels. Hydrogen was added, and carbon removed. New ways were found to rearrange and rebuild molecules and form new compounds.*

Gasoline demand rose steeply through most of the 20th century. Since the 1930s, there has also been growing demand for diesel fuel; since the 1940s, for petrochemical feedstocks, and since the 1950s, for aviation jet fuel. As Canada industrialized, markets burgeoned for specialty products such as lubricants and asphalt for roofing and paving. To meet these needs, about 50 refineries were built across Canada—from Vancouver to Come-by-Chance, Newfoundland—although 30 of these were shut down between 1970 and 2005 as production consolidated in large facilities able to meet increasingly sophisticated fuel requirements and stricter environmental regulations. The four large refineries on Ontario's Petroleum Peninsula, along the St. Clair River south of Sarnia and at Nanticoke, make it one of the nation's major centres for this industry. Other major refining centres are located in or near Edmonton, Montreal, and Saint John, New Brunswick.

In the first decade of the 21st century, Canada's petroleum refineries spent billions of dollars adjusting refining processes and equipment to meet the requirements of more efficient internal combustion engines and the related need to reduce smog. Problems with sulphur, the stinky old bugbear that frustrated the first kerosene producers, were not entirely resolved until $5 billion was spent to meet new regulatory requirements for ultra-low-sulphur gasoline and diesel fuels by 2005 and 2006.

* For a more detailed outline of petroleum refining processes, see *Our Petroleum Challenge*, published by the Canadian Centre for Energy Information, or the "How is oil refined?" section of the Centre's web portal, www.centreforenergy.com.

OIL REFINING
Refineries today still use the basic processes —distilling and cracking—at the heart of the refining process.
Credit: *Canadian Petroleum Association, 1969*



The silt and gravel left behind by glacial retreat covered the features that would have pointed to promising petroleum prospects. What American geologists could see clearly, their Canadian counterparts viewed through an opaque blanket.

The oil quest in the West

While motor vehicles launched rapid growth in demand for oil, the domestic crude oil supply in Canada actually diminished for decades. In the United States, meanwhile, the supply exploded. That country was the world's leading oil producer until the 1970s. The United States was also one of the world's largest oil exporters, rivalled only by Venezuela (after 1929) until big Middle Eastern fields came into production in the 1950s.

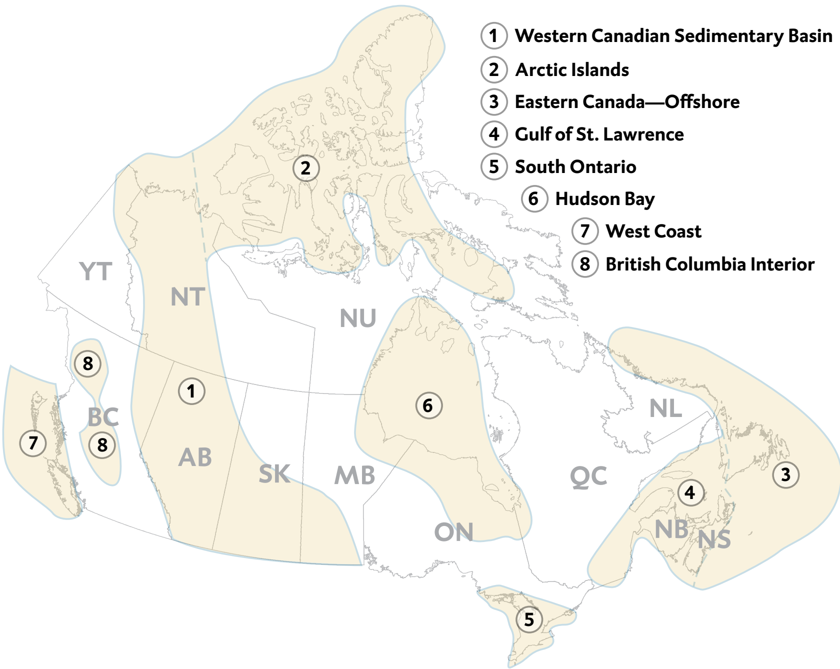
Imperial Oil, an affiliate of Standard Oil of New Jersey (now ExxonMobil) after the breakup of the Standard Oil Trust in 1911, has been Canada's largest petroleum refining and marketing company from 1880 to the present day. The company used multiple strategies to meet its growing supply requirements through the 20th century. In 1913, Imperial built a 155-mile pipeline from Cygnet, Ohio, to bring U.S. crude oil to the Sarnia refinery. A year later, Imperial established a subsidiary called International Petroleum that became a major oil producer in Peru, Columbia, Venezuela, and the Caribbean. Until Imperial sold International to Standard Oil of New Jersey in 1948, many Canadian geologists, drillers, and engineers—including some Petrolia hard oilers and their descendents—got their first experience in the steaming South American jungles and Andean highlands of South America. Crude oil from the southern continent provided most of the feedstock for Imperial's refineries at Dartmouth, Nova Scotia, and Vancouver, as well as for the Montreal refinery that was shut down in 1983.

The difficulty in Canada was that its petroleum wealth, with a few notable exceptions, was well hidden. It lay mostly in the West and the far Northwest, under prairie, forest, and tundra, in a vast sedimentary basin that stretches from the American border to the shores of the Arctic Ocean. More than three miles thick along the western edge and thinning towards the eastern and northeastern flanks, the basin embraces the southwestern tip of Manitoba, the southern half of Saskatchewan, nearly all of Alberta, the northeastern corner of British Columbia, and the Mackenzie Valley region of the Northwest Territories. As early as 1915, this enormous accumulation of sediments, deposited on the shores of ancient seas and later compressed into rock, was described by Eugene Coste as "an oil and gas belt of great promise," containing "future enormous reserves of petroleum."[8]

Unfortunately, there were few clues about where oil might be found one or several miles below the surface in this formidable mass of rocks. In the first seven or eight decades of the petroleum era, most oil was found from surface indications: either seepages of oil and gas, or anticlines, ridges that sometimes indicated underground structures where oil and gas had become trapped. There were no such surface indications for most of the oil hidden in the underground traps of this western basin. The silt and gravel left behind by glacial retreat covered the features that would have pointed to promising petroleum prospects. What American geologists could see clearly, their Canadian counterparts viewed through an opaque blanket.

There were a few exceptions, of course. We have already seen how the CPR accidentally discovered one of Canada's largest gas fields at Medicine Hat, a supply considered so large and cheap that the city's street gas lights were kept burning night and day rather than hiring lamp lighters to turn them on and off. More natural gas fields were found, usually in the search for oil. There was the Turner Valley field in the foothills of the Rocky Mountains southwest of Calgary, the largest oilfield in what was then still the British Empire during the Second World War, a field whose resources were uncovered by discoveries in 1914, 1924,

Potential Hydrocarbon Producing Areas



SEDIMENTARY BASINS
Canada's sedimentary basins, the likely areas for accumulations of oil and gas.
Credit: *Canadian Petroleum Association, 1969*

and 1936. There was an oilfield at Norman Wells in the sub-Arctic, discovered in 1920 on the banks of the Mackenzie River, too remote to be of much commercial value for half a century. There were the oilsands of northeastern Alberta, known by native people for millennia and by Europeans for nearly three centuries, but which defied attempts at successful commercial use until 1967.

Anticlines are concave folds in rock formations that often serve as traps for oil and gas reservoirs. A surface anticline at Turner Valley provided one clue that the area was worth exploring. A vent of natural gas on the surface provided another.

The first of the three discoveries at Turner Valley, in 1914, led to a trickle of oil, and to one of Canada's wildest stock market sprees. The drill bit at a lonely well in Turner Valley slowly pounded its way through hard rocks throughout 1913. Two of the partners in the well, William Herron and Archibald Dingman, were born in Ontario and had gained their previous oilfield experience in Pennsylvania. On its way down, their well encountered encouraging puffs of natural gas, wet with naphtha, whetting the appetites of speculators and leading the Calgary *Albertan* newspaper to ensure its readers that "it is only a matter of drilling now before a large quantity of oil is struck at the discovery well." Cashing in on the anticipated big discovery, promoters minted hundreds of paper oil companies, leased tens of thousands of acres of oil and gas rights from the federal government, and began selling shares to eager Calgarians.

When news reached Calgary on May 14, 1914, that the well had struck oil, Calgarians scrambled to buy oil shares as fast as they could be sold. The *News Telegram* concluded that the city "had a population of 80,000 people, mostly lunatics;" the *Albertan* said the city was "demented;" and the *Calgary Herald* said the stock promoters had "struck a financial gusher" that made the discovery

The Norman Wells field was discovered by Imperial geologist Ted Link in 1920. Sixty-five years later, nearly 90 per cent of the recoverable oil in this large field still remained to be produced.

well "look like a lawn sprinkler." The promoters sold shares of some 500 new companies, of which few ever drilled, and almost none of which ever found any oil or gas. The Calgary Petroleum Products Well No. 1 had found a thin oil zone at a relatively shallow depth. Only six oil wells were completed at Turner Valley during the field's first 10 years, producing oil at a combined average rate of less than 20 barrels a day. Calgarians were wiped clean of an estimated $1 million of their savings, worth $19 million in 2007 dollars. Worthless share certificates were used to wallpaper homes and the lobby of at least one hotel.

While Calgarians recovered from their Turner Valley financial hangover, in 1917, Imperial Oil launched a search for oil that spanned 30 years and reputedly more than 130 dry holes* before achieving any notable success. In charge of initial operations in this western and northwest campaign was an Ontario hard oiler, Alexander McQueen, former manager of Fairbank's oil-producing operations at Oil Springs and Petrolia.

En route to its seminal 1947 Leduc discovery that unlocked the secret to Alberta's richest oilfields, Imperial Oil found the Norman Wells oilfield on the edge of the Arctic Circle, and its Royalite subsidiary made the second of the three major discoveries at Turner Valley.

The Norman Wells field was discovered by Imperial geologist Ted Link in 1920. Sixty-five years later, nearly 90 per cent of the recoverable oil in this large field still remained to be produced. A small refinery at Norman Wells operated during the summer months, producing mainly aviation gasoline for bush aircraft. During the Second World War, Norman Wells briefly supplied oil for the $134-million Canol project, embracing some 1,200 miles of pipeline and a refinery at Whitehorse, to supply fuel for U.S. military bases in Alaska, guarding against a possible Japanese invasion. Canol was completed early in 1944, well after the threat of a Japanese invasion had faded, and operated for less than a year. In 1985, Norman Wells was finally connected to the crude oil pipeline network that now stretches as far south as the Gulf of Mexico, and the field at last began producing oil at a rate of more than 25,000 barrels per day.

The second Turner Valley discovery came in 1924, four years after the Norman Wells find. This discovery well was drilled by Royalite Oil Company, a 75-per-cent-owned subsidiary of Imperial Oil, and successor to Calgary Petroleum Products, which had brought in the small 1914 discovery. The wellsite geologist in charge of drilling at Royalite No. 4 was Neil McQueen, another hard oiler who grew up in the oilfields of Enniskillen, the son of Imperial's Alex McQueen. The well was timely as Royalite had just completed building a refinery in Calgary and depended otherwise on crude oil shipped by rail from Montana and Wyoming.

Below the thin oil zone found in 1914 lay one of Canada's largest reservoirs of crude oil and natural gas. The petroleum is trapped in the pores of a limestone rock, more than 300 million years old. The tilted layer of rock is faulted at its crest such that impervious rock forms a seal to trap any gas, oil, or water that could migrate upward through the porous limestone. Three trillion cubic feet of "wet" sour natural gas, containing naphtha and hydrogen sulphide, filled the top portion of the rock, followed by a layer of some 1.1 billion barrels of crude oil, and below that, salt water.

* Some historians and geologists are skeptical of the often-repeated assertion of "130 dry holes" by Imperial during this era. Alberta records indicate Imperial made at least two natural gas discoveries and two crude oil discoveries prior to 1947, and about 80 of its wells were listed as "development" wells, which indicated the company was looking for extensions of existing fields rather than new discoveries. However, it is true that the long exploration effort produced no major commercial successes comparable to later discoveries.

Turner Valley was also the scene of Canada's greatest energy waste. An estimated 1.8 trillion cubic feet of gas was flared in the 12 years between the discovery of the gas cap and the discovery of the oil column.

Royalite No. 4 drilled into the gas cap, releasing an explosion of natural gas, naphtha, and hydrogen sulphide. For 10 years, the well flowed gas at rates up to 20 million cubic feet per day, ultimately yielding a reported 925,819 barrels of naphtha.[9] More than 100 wells were drilled into the gas cap during a 12-year period before the oil column was discovered. The producers stripped out the naphtha and burned gas that could not be sold in gigantic flares. So large were the flares that Calgarians, 20 miles away, boasted that on some nights they could read their newspapers by their light.

It was 1936 before the oil column at Turner Valley was found at a depth of 6,828 feet by Turner Valley Royalties No. 1 well, a risky venture based on a geological theory in the money-scarce years of the Great Depression by a trio of Calgary financial gamblers: Robert Brown, manager of Calgary's electric light and street car system; George Bell, newspaper publisher; and John W. Moyer, lawyer. The presence of a deep oil reservoir had been indicated by traces of oil in nearby naphtha wells, and in one sense the "discovery" was an extension of the existing field. It took two years and two months to drill the well, and drilling stopped seven times while the promoters looked for more money, but it brought in one of Canada's biggest oilfields. Turner Valley was a vital source of oil during the Second World War, producing oil at rates up to 28,000 barrels a day from 232 wells.

Turner Valley was also the scene of Canada's greatest energy waste. An estimated 1.8 trillion cubic feet of gas was flared in the 12 years between the discovery of the gas cap and the discovery of the oil column. Because it reduced the reservoir pressure that helps lift the oil, overproduction of the gas also reduced the amount of oil that will ultimately be recovered from Turner Valley by at least an estimated half of a billion barrels. The amount wasted or rendered inaccessible is equivalent to more than Canada's total crude oil consumption during 2006. The bitter lessons learned at Turner Valley, however, led to some of the world's most efficient and effective petroleum conservation practices and regulations.

The Leduc discovery

By 1947, Canada had gone another 11 years without a significant oil discovery. Canada was using oil at a rate of 221,000 barrels a day, producing only 10 per cent of its needs, and the production rate was falling.

The trigger that shot Canada from a petroleum have-not nation to a petroleum exporter occurred on the grain farm of Mike Turta, 20 miles southwest of Edmonton. Imperial Oil Leduc No. 1, Imperial's latest wildcat in its 30-year western exploration program, was looking for oil in geological anomalies identified by a seismic survey the previous year. Previous oil finds in Alberta had been made in Lower Cretaceous sandstone, about 100 million years old, but the Leduc well would also penetrate into Devonian dolomite rocks, more than 400 million years old. Devonian rocks held the oil in both the original Ontario oilfields and at Norman Wells. Ted Link, then Imperial's chief geologist (after a stint as chief geologist for the Canol project), knew that the remains of Devonian coral reefs could contain prolific oil reservoirs.

However, the Devonian was not the main target of the Leduc well. The bulk of the world's crude oil deposits have been found in rocks of the Mesozoic Era, 65 to 248 million years old (including the giant oilfields in the Middle East, Canada's biggest oilfield, Pembina, and North America's biggest oil field, Prudhoe Bay on

LEDUC NO.1
A monument now marks the site of a historic 1947 discovery southwest of Edmonton.
Credit: *Oilweek*

the Alaskan North Slope). The Mesozoic Era includes the Cretaceous, Jurassic and Triassic periods. The Devonian Period belongs to the Paleozoic Era,* 248 million to 543 million years ago, which, while important, has yielded much less oil than the younger Mesozoic rocks. At a meeting in Toronto on March 19, 1946, at which the top geologists from Imperial Oil and its parent Standard Oil of New Jersey reviewed exploration prospects in western Canada, the decision was made to drill the Leduc well. Standard Oil's top geologist was skeptical about the chance of finding substantial oil in the Paleozoic beneath the plains of Western Canada. "The most favourable prospect in all Western Canada" was thought to be the Mesozoic's Lower Cretaceous formation in the Alberta Geosyncline, minutes of the meeting report. "This is considered to be the most important portion of the most promising or prospective area in Canada for immediate attention." [10]

The Leduc well found only a small amount of oil in the Lower Cretaceous, but at a greater depth found oil in a Devonian formation. Imperial's second well at Leduc discovered a deeper and more prolific Devonian oil section. The bit churned into sponge-like dolomite rock with pores big enough to stick your finger in. The pores were filled with oil.

The dolomite rock was a reef, built on the edge of an ancient Devonian sea. It turned out that huge Devonian reefs were buried beneath the plains of Alberta. The emerging science of geophysics and seismic surveys helped to locate these storehouses of energy that had escaped discovery from scores of wells drilled in Alberta during nearly a century of oil searching. During the next half century, Devonian reefs accounted for more than half of the conventional crude oil discovered in Alberta.

* The Paleozoic Era includes (from oldest to youngest) the Cambrian, Ordovician, Silurian, Devonian, Carboniferous, and Permian periods.

The pipelines

One of the challenges of petroleum is that most of it is found far from where most of it is used. This is especially so in Canada, with its vast distances and relatively small population. To meet this challenge, Canadian companies have built and continue to operate some of the world's largest and longest pipelines, which are the safest and lowest-cost means of transporting these valuable substances. Largely unseen and silent, few Canadians are aware of this 217,00-mile network of energy arteries that rivals the more visible transportation networks of road, railways, and electric power lines.† Canada's pipelines are also connected with many U.S. pipelines, providing a North American network of more than 750,000 miles to deliver Canadian oil to refineries and natural gas to consumers.

The problem of distant markets soon confronted Imperial Oil after its 1947 Leduc discovery confirmed the oil potential of the big Western Canada Sedimentary Basin. To provide an immediate outlet for its Leduc oil, Imperial bought the 3,000-barrel-per-day mothballed oil refinery built at Whitehorse in the war-time Canol project, took it apart, and hauled the 7,000 tons of pieces some 1,200 miles to Edmonton. When the much larger Redwater field, northwest of Edmonton, was found the year after Leduc, it was soon apparent that neither Alberta nor all the prairie provinces would be able to use all the oil that would soon be available. Sarnia was Canada's biggest refining centre. By railway, the cost of transporting oil from Edmonton to Sarnia would be \$3.24 per barrel, but the cost by pipeline would be about one-quarter of that amount. Since the price of

† Pipeline systems as of 2001.12.31. Oil: field gathering, 12,536 km; trunk, 29,979 km; refined products, 5,670 km. Gas: field gathering, 7,260 km; transmission, 83,614 km; distribution, 216,864 km. Statistics Canada. *Pipeline Transportation of Crude Oil and Refined Petroleum Products, 2001. Natural Gas Transportation and Distribution 2001.*

SARNIA REFINERIES IN 2008
Refinery Row today lights up the night sky.
Credit: *Robert Bott*

American oil delivered to Sarnia by pipeline in 1949 was $3.55 per barrel,[11] only a pipeline could supply Ontario refineries with Alberta oil at a cost competitive with U.S. crude delivered by existing pipelines.

Interprovincial Pipe Line Company was incorporated on April 30, 1949, to undertake the job. The line would be financed and owned initially one-quarter by Imperial, one-third by other oil companies, with the rest widely held through a public share offering. The plan was to build it in sections, starting with a 450 mile line from Edmonton to Regina. With new oil discoveries coming in fast, a decision was then made to go ahead with a 1,100 mile pipeline to Superior, Wisconsin, at the head of the Great Lakes. Imperial would build two of the world's largest lake tankers to move the oil from Superior to Sarnia. During the five months of the year when Great Lakes shipping is closed, crude oil delivered by the pipeline to Superior would be stored there in tanks capable of holding 1.5 million barrels.

The decision to route the line east of Gretna, Manitoba, and through American territory to a U.S. terminal at Superior, was based on economics, but it ran into a political storm. The pipeline route to Superior was about 125 miles shorter than a route to a Canadian port at the twin cities of Fort William and Port Arthur (both now incorporated into the city of Thunder Bay). Ultimately a pipeline route through Wisconsin and Michigan, all the way to Sarnia, would be even shorter than an all-Canadian route north of the Great Lakes. An additional consideration was that the U.S. route might some day be used to deliver Canadian oil to refineries in the U.S. Midwest.

The business people and politicians of Fort William and Port Arthur were not mollified. They campaigned against the American pipeline route. In the House of Commons they found an ally in the Progressive Conservative opposition that demanded the delivery of Canadian energy to Canadian consumers by all-Canadian pipeline routes. During House debate on the issue, Howard Green, Conservative member for Vancouver-Quadra, declared, "I think the plan is to sell a great deal of the oil in the United States." "Is there anything wrong with that?" asked Trade Minister C.D. Howe, who was convinced to back the U.S. route even though Port Arthur was the constituency that elected him.[12]

Politics lost that battle; economics won. The following year, 1950, the pipeline was built from Edmonton to Superior in 150 days. Never had such a lengthy and large pipeline been built so quickly. The terminal and storage tanks at Superior and the two lake tankers to deliver Alberta oil to Sarnia were used for only three years before the pipeline was extended more than 600 miles to Sarnia. In 1956, it was extended to the outskirts of Toronto. At more than 2,000 miles, it was the world's longest oil pipeline, and still is. Now owned by Enbridge Energy, the extended former Interprovincial pipeline now includes nearly 8,700 miles of mainline pipe in Canada and the United States.

Canada's second large oil pipeline was built while the Interprovincial line was being extended to Sarnia. The 715-mile Trans Mountain pipeline from Edmonton to the Vancouver area and the adjacent U.S. Puget Sound, traverses the rugged mountain of Alberta and British Columbia, and was completed in 1953. The pipeline is now owned by Kinder Morgan Canada.

Major natural gas pipelines followed. Long before Leduc, there were networks of small-diameter pipelines supplying natural gas to consumers within southwestern Ontario and within Alberta. Because every office building, store, factory, and house supplied with gas requires a pipeline connection, the

At Athabasca, the largest bitumen deposit, the oilsands vary in thickness from about one yard to 100 yards over an area of nearly 3,100 square miles—larger than Lake Ontario.

distribution systems of Canada's natural gas utilities today account for 60 per cent of the total oil and gas pipeline mileage.*

Canada's first large-diameter, long-distance natural gas pipeline was not completed until 1957, the culmination of a 26-year vision by wildcatter and promoter Frank McMahon to supply his native British Columbia with natural gas. Stretching 1,242 miles from Fort St. John in northeastern British Columbia to Vancouver and the nearby American border, the Westcoast Transmission pipeline supplied gas to most B.C. communities, as well as feeding an American network that supplies consumers in the U.S. Pacific northwest. It is now owned by Spectra Energy Transmission.

The next "big inch" gas pipeline was completed the following year, but not before measures by the Liberal government to provide federal assistance in financing the project had provoked the most the raucous debate that Canada's Parliament has ever seen. The debate contributed directly to the defeat of the Liberal government in 1957. But when the last weld was made in 1958 on the 2,100-mile system of Trans-Canada Pipe Lines, on an all-Canadian route from Alberta to Montreal, it was the world's longest natural gas pipeline, longer even than Interprovincial's oil pipeline.

Although few are aware of Canada's networks of oil and gas pipelines, they are as vital to life in our advanced industrial economy as any mode of transportation.

* Some of the original local distribution systems in cities such as Vancouver, Calgary, Toronto, and Montreal were built for coal gas and were later converted to natural gas when it became available.

† The peak year for conventional crude oil production in Canada was 1973. Production dropped almost 30 per cent over the next two decades before recovering somewhat in the 1990s due to improved recovery methods. A second peak, about 20 per cent below the 1973 level, appears to have occurred in 2003. (See Canadian Association of Petroleum Producers, www.capp.ca 2007 Statistical Handbook.)

The Alberta oilsands

Canada, as already noted, was importing 90 per cent of its crude oil requirements from the United States and South America when Imperial Oil discovered Leduc in 1947. Sixty years later, daily oil consumption had increased 10-fold. Meanwhile, Canadian crude oil production not only kept pace with vastly greater domestic needs, but exceeded them by 50 per cent. While consuming 2.1 million barrels of oil per day in 2006, Canada produced some 3.1 million barrels per day. This occurred despite the fact that Canada's output of conventional crude oil from the big western Canada basin had passed its peak † and was inexorably declining. The largest discoveries there were made between 1947 and 1965. During the 37-year period to 2006, Canada produced twice as much oil as it found and developed; remaining discovered conventional oil reserves were cut in half.[13]

Canada would inevitably return to the status of a have-not oil nation again except for one Herculean development: production of synthetic crude oil from the bitumen in the oilsands of northern Alberta. Rivalled only by the conventional oil reserves of Saudi Arabia and Venezuela's extra-heavy-oil deposits, the oilsands represent one of the largest petroleum resources in the world. Mixed with sand, clay, and other materials are close to two trillion barrels of sticky tar-like bitumen. Three deposits cover a combined area twice as great as New Brunswick: the Athabasca, Cold Lake, and the Peace River oilsands. Less than 10 per cent of the bitumen in these deposits is now considered economically recoverable, but at 174 billion barrels, that is exceeded only by the oil reserves of Saudi Arabia, though Venezuela claims up to 235 billion barrels of its Orinoco heavy crude is recoverable. It took more than a century of effort to economically wrest the bitumen from the sand. If this is any guide to the future, continuing process

ATHABASCA OILSANDS
Oilsands are mined with some of the world's biggest trucks and shovels.
Credit: *Robert Bott*

improvements and new technology might well substantially increase present estimates of the amount of oilsands bitumen ultimately recovered and converted into synthetic crude oil.

At Athabasca, the largest bitumen deposit, the oilsands vary in thickness from about 1 yard to 100 yards over an area of nearly 3,100 square miles—larger than Lake Ontario. Most of the oilsands are covered with overburden as much as 760 yards thick. Where the overburden is less than 80 yards, oilsands can be excavated in open-pit mining using the world's largest trucks and shovels. Bitumen covered with deeper overburden must be produced in situ, primarily by pumping super-heated steam down wells, and pumping up a slurry of water and bitumen. Other possible methods of in-situ production include the use of other sources of heat (including combustion of part of the bitumen) or solvents to free the oil so that it can be pumped to the surface. More than half of the bitumen now being produced is recovered from surface mining. Yet 90 per cent of the bitumen presently considered economically producible lies too deep to be mined.

The bitumen in the Alberta oilsands is not like the tar from Trinidad's "pitch lake" or New Brunswick's albertite, from which Abraham Gesner first produced kerosene; nor is it like the gum beds on the banks of Black Creek in Enniskillen township which Charles Tripp mined for paving and sealing material, and which James Miller Williams used to refine for kerosene before finding the underlying crude oil. The Trinidad, New Brunswick, and Black Creek deposits were close to pure bitumen. Alberta's oilsands contain only 10 to 12 per cent bitumen; the rest is sand, clay, other minerals, and water. Separating the bitumen from the sand and other material was the most intractable problem confronting successful exploitation of the oilsands, a problem that Gesner, Tripp, and Williams did not face. Canada's bitumen pioneers had enough other problems to deal with.

To extract bitumen from Alberta oilsands, government and oil company researchers as well as a few wild-eyed promoters tried or proposed such measures as hot water, steam, underground fires, a giant centrifuge inspired by a household washing machine, microbes intended to dine on the bitumen and defecate oil, and an underground nuclear explosion. Their efforts spanned 84 years of frustration, failures, and shattered dreams before the first successful large-scale commercial production was finally achieved.

For thousands of years, native people had used bitumen oozing from the banks of the Athabasca River to caulk their canoes. Hudson's Bay Company traders heard reports of the oilsands as early as 1714, and the earliest recorded first-hand observations were made by fur trade explorers Peter Pond and Alexander Mackenzie in 1788 and 1789. Robert Bell of the Geological Survey of Canada visited the Athabasca oilsands in 1881 and in a report three years later envisioned a network of river and lake steamers and a pipeline to Hudson Bay to ship to world markets the crude oil that he was certain would be found at greater depths. GSC chemist and metallurgist G. Christian Hoffman analyzed a sample of Bell's oilsand and concluded that, as is, it would be ideal for paving. Alternatively, the bitumen could be separated "by simply boiling… the material with hot water." The sand would fall to the bottom and oil and froth would rise to the top where it could be skimmed off. It was not as simple as Hoffman described, but the idea was sound; it was the basic approach that ultimately led to success, following significant modifications resulting from decades of research and development work.

Sarnia remains a major petrochemical centre with an infrastructure that Industry Canada says is surpassed in North America only by the U.S. Gulf Coast.

Large-scale commercial production from the Athabasca oilsands began in 1967 with the completion of the $280-million ($1.7-billion in 2007 dollars) surface mine and processing plant of Great Canadian Oil Sands, now Suncor Energy, designed to produce synthetic crude oil at a rate of 45,000 barrels per day. At GCOS, and at the larger mining projects that followed, the oil, sand, and other matter are separated in large treating plants, primarily with hot water. The recovered bitumen is too viscous to be transported by pipeline. It is either refined into synthetic crude oil at the mine site or diluted with lighter liquid petroleum such as condensate, similar to naphtha, which is stripped from wet natural gas. The diluted bitumen or the synthetic crude oil is then ready for shipment through the network of oil pipelines to refineries throughout Canada and the United States.

In the case of in situ production, where steam is injected through vertical or horizontal wells into the buried oilsands and bitumen pumped to the surface, much of the sand is separated from the bitumen underground.

Forty years after the Great Canadian Oil Sands plant began producing with its design capacity of 45,000 barrels of synthetic oil, oil companies' cumulative investment of $48 billion had increased production to more than one million barrels per day. By 2015, with a projected investment of more than $130 billion, oilsands production is expected to hit three million barrels per day.* This oil is likely to be needed, even if oil consumption is reduced to curb global warming. Canada, the United States, and Mexico together in 2006 produced little more than half the oil they consumed, a shortfall of more than 11 million barrels per day, while production of conventional crude oil continued to decline.[14] Yet the economic, engineering, and especially environmental challenges confronting continued oilsands development are perhaps not much less daunting than those of the past century. Those challenges will be briefly discussed in the next chapter.

* Crude oil remaining established reserves estimated at 1,666 million cubic metres in 1969 and 828 million in 2005. (See Canadian Association of Petroleum Producers' *Statistical Handbook 2007*, table 2.6a.)

Ontario's petrochemical complex

The possibility that petroleum might someday be "too valuable to burn" emerged in the 1930s when techniques were perfected to produce synthetic rubber from byproducts of oil refining such as butadiene, styrene, and ethylene. Lambton County once again played a pivotal role as the birthplace of Canada's petrochemical industry, which helped turn the tide of victory in the Second World War.

On December 7, 1941, the "day of infamy," Japanese forces not only wiped out much of the American navy at Pearl Harbour but also launched attacks that quickly overran 90 per cent of the world's rubber supply in the plantations of Southeast Asia and the South Pacific, "placing the whole Allied war program in jeopardy."[15] Despite a century of research and development, the production of synthetic rubber from oil was still in its infancy, its uses limited, its price and quality inferior, and the technology for a better product largely untested beyond the laboratory.

That did not stop Canada's dynamic Minister of Munitions and Supply, C.D. Howe. Just 20 days after Pearl Harbour, Howe committed the Government of Canada to spend $50 million, its largest single wartime project, to build a synthetic rubber plant under the aegis of a new Crown entity, Polymer Corp., at Sarnia where Imperial's refinery, the largest in the British Empire, would provide the chemical feedstock. The project required the leading effort of half a dozen companies, a workforce of 5,600, and construction of 10 factories. Polymer began producing synthetic rubber in September 1943, nine months ahead of schedule,

enough to meet Canada's wartime needs and later enough for export to world markets. In 1941, all the rubber consumed in Canada came from trees; three years later, 90 per cent came from petroleum.

Sarnia remains a major petrochemical centre with an infrastructure that Industry Canada says is surpassed in North America only by the U.S. Gulf Coast. It includes three oil refineries, dozens of related facilities, a natural gas liquids pipeline from Alberta providing more feedstock, other crude oil and refined product pipelines, large underground salt storage caverns, a tanker terminal for offshore shipments, and ready access to North American markets.

CHEMICAL VALLEY
Refineries and petrochemical plants stretch out along the St. Clair River south of Sarnia. Versatile petroleum molecules form the basis for thousands of industrial, commercial, and consumer products. Credit: *Joey Podlubny*

CHAPTER 6

FOSSIL FUELS IN THE 21ST CENTURY

Historians, living in the present, are always at a crossroad. We can know the past, but cannot change it. We cannot know the future, but it can be changed. Knowledge from the past can help us make better decisions to shape more desirable futures, wherein lies the principal reason to study history. In that spirit, we now look beyond the present intersection at some of the routes currently visible ahead..... There are undoubtedly many other paths currently unforeseeable.

FOOD AND ENERGY
Feast on a 300-gram T-bone steak, and you have consumed a litre of oil. And it is not just meat; it is difficult to name any foods that are produced or harvested without the use of petroleum.
Credit: *Robert Bott*

Two diametrically opposed challenges confront the 21st century:

- Curb emission of planet-warming greenhouse gases from burning fossil fuels—coal, crude oil, and natural gas—and address local and regional environmental issues such as smog, acid rain, and mercury pollution related to fossil fuel consumption.
- Provide the increased energy needed to support an additional 2.5 billion or more humans who will inhabit the globe by mid-century, plus additional energy to improve the lives of 2.5 billion people now suffering poverty, chronic hunger, and brief life expectancies. (World population in July 2007 was estimated at approximately 6.6 billion.)

Efforts in affluent countries to curb greenhouse gas emissions with low-emission fuels and reduced consumption will, for at least the first half of the century, almost certainly be overwhelmed by population growth and the rise of per-capita income in China, India, and elsewhere. However, not all the greenhouse gases generated by increased energy use need be vented into the atmosphere and thereby add to global warming: much can be stored or "sequestered" deep underground. This "carbon capture and storage" could be especially important in Canada, where oilsands production, which generates large quantities of carbon dioxide, is expected to be the single largest source of energy growth in North America. By mid-century, energy experts and environmentalists say, global greenhouse gas emissions could be on the decline. Bodies such as the United Nations' climate panel and the International Energy Agency see clean, sustainable fossil fuels as a crucial part of efforts to curb global warming.

Ubiquitous petroleum

Crude oil and natural gas play bigger roles in our everyday lives than we generally realize. To see how much bigger, imagine a mad magic wand that causes everything made in whole or in part from petroleum to disappear.

Ships, planes, trains, and motor vehicles would come to a halt. Even if your car were fuelled with biodiesel, it would not go far without the tires made from oil or natural gas. The plastic steering wheel, the vinyl upholstery, and dozens of other components would be gone. If your car has a fibre body, you would have a skeleton of scrap steel.

Women would be without lipstick and nylons. With the vanishing of many shoes, socks, shorts, shirts, and other clothing made with petrochemical products, multitudes would suddenly be nearly nude.

Food would be scarce. It takes more than 900 litres of petroleum (oil products or, in some instances, an energy-equivalent portion of natural gas) to raise a 560-kilogram steer—to fuel farm equipment, and for fertilizer to grow the steer's feed of corn or grain.[1] That is more than 1.5 litres per kilogram of steer; undoubtedly more than 3 litres of oil per kilogram of meat by the time the steer is transported and butchered, the hide, horns, and other non-edible parts removed, and the meat marketed. Feast on a 300-gram T-bone steak, and you have consumed a litre of oil. And it is not just meat; it is difficult to name any foods that are produced or harvested without the use of petroleum.

Lacking petroleum products, your house would be in shambles. Gone would be asphalt shingles, insulation, polyvinyl siding, and carpets. The television, telephone, computer, and a dozen other appliances would lie collapsed in piles of junk. Do not flush the toilet because the polyvinyl chloride (PVC) piping in

Since the start of the Industrial Revolution in 1750, the concentration of CO_2 in the atmosphere has increased more than one-third, from 280 to more than 379 parts per million.

the basement has disappeared. It would not matter, in any event, since without insulation on the electrical wiring, your house would be going up in flames.

In these and many other ways, petroleum is an integral part of everyday life. Yet crude oil and natural gas—and even more so, that third fossil fuel, coal—have induced a cost that needs mitigating: that of global warming.

The challenge of a warming world

"Warming of the climate is unequivocal" is the blunt assessment of some 130 world scientists in the Fourth Assessment Report of the United Nations' Intergovernmental Panel on Climate Change.[2]

Blame the buildup of gases in the greenhouse roof that envelopes our planet. This roof of water vapour and gas, not glass, keeps the earth warm by trapping heat from the sun, much like the roof of a garden greenhouse. Without a greenhouse roof, the earth would be a frozen ball, the oceans would be solid ice, and life as we know it would be impossible. Now, however, we have added so much heat-trapping gas to this roof that the climate is getting uncomfortably warm.

The main human-caused greenhouse gas (GHG) is carbon dioxide (CO_2), the seemingly harmless stuff that we and other animals exhale and plants inhale, the fizz in soda water and other soft drinks. It accounts for more than three-quarters of the GHGs that result from human activities, "anthropogenic" greenhouse gases in the parlance of scientists. Methane, which is essentially natural gas, and oxides of nitrogen are two other GHGs.

Nature's balance between the amount of CO_2 that goes up in the air and that which comes down to earth to be absorbed by plants, soils, and oceans, has been upset mainly by increasing amounts of CO_2 generated by burning fossil fuels. The amounts vary. Burning coal contributes the most CO_2 per unit of energy, and also the most air pollution, from oxides of nitrogen, sulphur dioxide, other chemical compounds, mercury, and particulate matter. Burning oil and its products produces about three-quarters as much CO_2 as burning coal, while natural gas generates only about half as much CO_2 as coal.* In addition to fossil fuels, other sources of anthropogenic CO_2 include deforestation, agriculture, and burning biomass.

Since the start of the Industrial Revolution in 1750, the concentration of CO_2 in the atmosphere has increased more than one-third, from 280 to 379 parts per million. Since 1850, when extensive records were first kept, the Earth's average temperature has increased by 0.75 degrees Celsius, and more than that in northern latitudes, especially Arctic regions. IPCC scientists project an increase of another 0.4 degrees or more by 2025.

That might not seem much warmer, until you consider the effects already experienced. Oceans have been warmed to depths of at least three kilometres, causing the water to swell, contributing to inexorably rising sea levels. Shrinking glaciers and polar ice have also helped ocean levels rise by an estimated 17 centimetres in the 20th century, mostly in the final decades. The permafrost in Canada's Arctic and sub-Arctic regions is warming. There have been more frequent and more intense droughts; more forest fires; more flooding; more frequent and more intense storms (hurricanes, tornadoes, and cyclones); more "hot days, hot nights and heat waves."[3]

Expect more of the same throughout this century, and for the next thousand years or so. Because CO_2 stays in the atmosphere for some 200 years, global warming is a very long-term trend. The IPCC 2007 report concludes that:

* These appoximate ratios vary with differing properties of coal, oil, and to a lesser extent, natural gas. (See Mark Jaccard's *Sustainable Fossil Fuels: The Usual Suspect in the Quest for Clean and Enduring Energy*.)

Forty per cent of the world's population, 2.5 billion people in developing countries, burn wood, charcoal, crop residues, and animal dung to cook, heat their homes, and provide light.

> Both past and future carbon dioxide emissions will continue to contribute to warming and sea level rise for more than a millennium, due to the timescales required for removal of this gas from the atmosphere.

Choking on bad air

The atmosphere is also being inundated with oxides of nitrogen, sulphur dioxide, particulate matter, and volatile organic compounds—pollutants that are estimated to kill at least two million people a year. Ironically, the biggest culprit here is not fossil fuels, but burning wood and other biomass: renewable energy that is widely seen as essential to help curb global warming.

Emissions from burning fossil fuels at coal-fired thermal electric power plants and tailpipe emissions from motor vehicles are the main source of urban outdoor air pollution, which Environment Canada in 2007 said is linked to the death of 5,900 Canadians every year. In the United States, the annual toll is estimated at 41,000, and worldwide, at 800,000. But the bigger killer around the world is indoor air pollution from burning biomass.

Converting biomass into such biofuels as ethanol and biodiesel, or burning it to make electricity, are in the forefront of efforts to curb greenhouse gas emissions. However, 40 per cent of the world's population, 2.5 billion people in developing countries, burn wood, charcoal, crop residues, and animal dung to cook, heat their homes, and provide light. The energy from these sources is equivalent to 20 million barrels of oil per day, or 23 per cent of 2006 world oil consumption. The result is "severe consequences for health, the environment and economic development," notes the International Energy Agency. "Shockingly," adds the IEA, "about 1.3 million people—mostly women and children—die prematurely every year because of exposure to indoor air pollution from [burning] biomass."[4]

Limiting global warming

While continued rising temperatures and sea levels appear unavoidable, IPCC scientists conclude that atmospheric concentration of CO_2 could be stabilized by 2030 at 445 to 710 parts per million, from one-third more to as much as double the 2005 level. Measures prescribed to achieve stabilization are:

- greater use of renewable energy (wind, solar, biomass fuels, geothermal, and tidal energy)
- nuclear power
- greater energy efficiency to reduce demand
- clean fossil fuels
- carbon capture and storage

Renewable energy

Canada's oil companies have been among the leaders in developing renewable energy. Three Canadian oil and gas firms, Suncor Energy, Enbridge, and Nexen, had wind farms generating electric power in 2007, with more under construction, representing one-fifth of Canada's wind power.

Suncor, the largest producer of synthetic oil from the Alberta oilsands, is also Canada's largest producer of ethanol, the alcohol that is blended with gasoline to reduce CO_2 emissions and air pollution from autos. Ethanol currently is made from agricultural crops—corn, wheat, soy beans, and sugar cane—but almost entirely from corn in North America. This first-generation ethanol is controversial: it is energy intensive. Estimates vary, but U.S. studies indicate that the energy-equivalent of one litre of corn-based ethanol is consumed to produce just 1.3 litres of

ETHANOL FROM GRAIN
Making ethanol from grains such as corn or wheat consumes almost as much energy as it produces.

the fuel (and this calculation does not include the energy costs from indirect effects such as clearing forest for energy crops or taking food crops out of production). Thus the net reduction in CO_2 and air pollution is limited. It takes billions of dollars in taxpayer subsidies. Sugar-cane ethanol from Brazil and other tropical countries is much more energy-efficient, producing up to eight litres of fuel for each energy-equivalent litre consumed, and the cost is about one-half the cost of corn-based ethanol.

The potential of current ethanol technology is limited. The United States currently accounts for 40 per cent of the entire world production of corn, yet if all that corn were converted to ethanol, it would replace only 12 per cent of American gasoline consumption. Critics say that corn-based ethanol amounts to burning food in a starving world. Agricultural and food economists at the University of Minnesota claim that burning corn-based ethanol could increase the number of chronically hungry people in the world by 800 million.[5]

Cellulosic ethanol is a second-generation ethanol technology that proponents say will avoid using food for fuel, and achieve deeper GHG reductions. Two oil companies are heavily involved in advancing Canada's position as the world leader in this technology. Cellulosic ethanol is produced from agricultural and wood waste such as wheat straw, corn stover, wood residue, and switchgrass. Enzymes and catalysts speed biochemical reactions to break down the cellulose. Because it uses waste material and less energy than a corn distillery, cellulosic ethanol is said to be 90 per cent lower in greenhouse gas emissions than gasoline, compared with about 30 per cent lower for corn-based ethanol. In 2007, Iogen Corporation, a largely family-owned firm, operated the world's only demonstration-scale cellulosic ethanol plant on the outskirts of Ottawa. Following nearly 30 years of research and development work, Iogen's $40-million plant began producing EcoEthanol in January 2003.

Petro-Canada and the Royal Dutch/Shell Group, the world's second-largest oil company and largest producer of biofuels, are both major contributors to Iogen's capital investment and research and development expenditures. Petro-Canada provided $15.8 million toward the cost of the demonstration plant and Shell invested $45.5 million for a 22 per cent interest in Iogen.

In the February 2007 budget, the federal government said it would provide $500 million to help establish "large-scale facilities for the production of next generation" of biofuels. Iogene reportedly plans to build its first—and perhaps the world's first—commercial-scale cellulosic ethanol plant at Prince Alberta, Saskatchewan.

Per litre, cellulosic ethanol currently costs more to produce than ethanol from food crops. But measured instead by the amount of reduced greenhouse gas emissions, it is likely cheaper. A full-scale commercial plant should help determine the economics.

Both the IPCC scientists and the IEA see rapid growth in non-fossil fuel energy with low or no GHG emissions. During the 25-year period to 2030, the IPCC says the share of electricity generated by renewable energy (primarily hydro, wind, biomass, and solar) could be as much as doubled from 18 per cent to 35 per cent, while nuclear energy's share might increase from 16 to 18 per cent. Biofuels could supply as much as 10 per cent of the energy used in transport, up from 3 per cent.[6]

CUTTING FUEL USE
High prices encourage motorists to consider more effcient vehicles and alternatives such as carsharing.
Credit: *Robert Bott*

The sizzle of energy savings

"Efficiency is the steak," claims Carl Pope, executive director of the Sierra Club. "Renewables are the sizzle."

Pope was commenting on the view of environmentalists and energy authorities alike that increased efficiency to reduce energy use promises the biggest, cheapest, quickest reductions in greenhouse gas emissions.

From compact fluorescent light bulbs that reduce household energy use, to recovery of waste heat that allowed Syncrude Canada to cut energy costs by $2.5 million over two years and reduce greenhouse gas emissions by 25,000 tonnes in extracting bitumen from the Alberta oilsands,[7] the opportunities to reduce energy use and save money abound. One of hundreds of examples is another bright light idea. EnCana, Canada's largest independent petroleum producer, is providing $2.1 million to help finance a three-year program to demonstrate commercial feasibility of a new light bulb said to use only 10 per cent as much energy as a conventional light bulb—more energy efficient and lasting 10 times longer than compact florescent light bulbs.

Highways are another area of big potential energy and GHG emission savings. Hybrid electric-gas vehicles have proliferated since the first such mass-produced vehicle was introduced by Toyota in 1997. Now, bigger savings are promised from ultra-low-emission electric-diesel vehicles, and from a new type of electric-gas vehicle. Honda reportedly plans to offer an ultra-clean diesel hybrid that will use 3.6 litres of fuel per 100 kilometres. General Motors plans to offer a plug-in electric hybrid in 2010 in which a small gasoline motor will be used only to charge lithium-ion batteries between six-hour plug-in charges. It will reportedly drive 64 kilometres on the battery alone and get 1.6 litres per 100 kilometres on 97-kilometre trip, embracing most daily commutes. On a maximum trip of 1,030 kilometres between plug-in charges, it would reportedly still deliver 3.9 litres per 100 kilometres.

Amory Lovins, a leading advocate of energy conservation, claimed in 2002 that the annual U.S. electric bill of $220 billion could be cut in half by means of consumer and business measures "that would mostly pay for themselves within a year," while still providing cold beer, bright lights, and hot showers.[8] Some of the savings advocated by Lovins have already been achieved.

Consumers could see even greater savings, in energy and money, according to the IEA. By investing $2.4 trillion, consumers could "see savings in their energy bills of $8.1 trillion" between 2005 and 2030.[9]

Unfortunately, improvements in energy efficiency so far in this century have been overwhelmed by more intensive energy use to lift living standards in developing countries. In the final three decades of the 20th century, the amount of energy used worldwide to provide a given amount of goods and services declined by one third. Since then, that trend has been reversed, by the rapid growth in use of coal for power generation in China and elsewere.[10]

Hydrogen highways?

Hydrogen-fuelled vehicles are in a class apart. Hydrogen is not a renewable fuel since it is produced principally from natural gas, and, barring breakthroughs in electricity production and electrolysis technologies, it is likely to come from fossil fuels for the foreseeable future. The great virtue is that hydrogen-fuelled vehicles emit almost no pollution. The hydrogen can be either burned in modified conventional gasoline or diesel internal

Natural gas is expected to be the principal source of hydrogen, for both possible hydrogen vehicles and other uses such as small-scale power generation, for at least the first three decades of the century.

combustion engines, or used in fuel cells that chemically combine hydrogen and oxygen to produce electricity. Nearly every automotive company is demonstrating or developing one or the other of these two types of hydrogen vehicles—and in some cases, both— with hundreds of hydrogen cars, trucks, and buses already being tested on roads across Canada and around the world.

Fuel-cell vehicles offer the greatest potential for greenhouse gas reductions since the only by-product of the electricity they generate is water. Combustion hydrogen vehicles are seen as less costly and easier and quicker to bring to market since they can use existing gasoline or diesel engines with relatively minor modifications.

Hydrogen combustion engines omit no CO_2 but they do emit oxides of nitrogen, most of which might be captured before it exits from the tail pipe, resulting in "near-zero" GHG emissions.

Hydrogen vehicles get a lot of attention. The world's first large hydrogen-combustion passenger bus was demonstrated in 2005 on Winnipeg's transit system. In 2007, British Columbia was working on building a fleet of 20 fuel-cell buses and, together with western U.S. states, the world's longest "hydrogen highway" with fuelling stations from Whistler, the scene of the 2010 Winter Olympics, to San Diego, California. BMW, after almost 25 years of development, provided 100 dual-fuel, gasoline-and-hydrogen luxury sedans for demonstration use by 100 celebrities, from scientists to rock stars. Ford Motor Company provided 30 more modest fuel-cell versions of its Focus passenger vehicles to public officials in Vancouver and six other cities in the United States and Germany, while also providing 30 12-passenger hydrogen-combustion shuttle buses for demonstration work at airports in Canada and the United States.

Yet large-scale commercial adoption of hydrogen vehicles still faces challenges. One is vehicle fuel storage, since hydrogen takes much more space for a given amount of energy than gasoline, diesel fuel, or natural gas; even hydrogen liquefied at -253° C still contains less energy per litre than gasoline.

A bigger challenge is manufacturing the hydrogen while emitting very low or no GHGs. Energy experts claim that all the renewable energy that can be made available this decade will do more, at less cost, to reduce greenhouse gas emissions by generating electricity and low-emission fuels than if it were used in producing hydrogen. Natural gas is expected to be the principal source of hydrogen, for both possible hydrogen vehicles and other uses such as small-scale power generation, for at least the first three decades of the century.[11] To minimize greenhouse gas emissions, the CO_2 that comes with producing hydrogen by the current method, steam-stripping natural gas, would have to be injected into deep reservoirs.

There is disagreement about how soon commercial use of hydrogen vehicles can be achieved. John Lapetz, the program manager for Ford's hydrogen-combustion vehicles, says it might be possible to bring such cars to market as early as 2012.[12] Physicist and former U.S. Department of Energy official Joseph Romm says, "Not in our lifetime, and very possibly never." Romm claims that "a hydrogen car is one of the least efficient and most expensive ways to reduce greenhouse gases."[13] Like so much else in a time of global energy change, the best answers to these and other puzzles are most likely to come from the pursuit of competing concepts.

Returning CO_2 to old oil and gas fields would be returning it to reservoirs where it had been trapped for millions of years.

Mitigation overwhelmed

Despite savings from improved efficiency and greater use of renewables, world demand for energy by 2030 is expected by the International Energy Agency (IEA) to increase by 37 per cent. This assumes that governments implement all of the energy savings and GHG mitigation measures and policies now being considered. Under existing measures, demand is projected to increase 50 per cent. More than 70 per cent of the increase in the projected lower-growth energy demand, and essentially all of the increased CO_2 emissions, will come from less-developed nations, striving to increase living standards for growing populations. Half the increase in world energy demand will come from China, mainly due to its use of coal to generate electricity. In 2007, China replaced the United States as the world's largest emitter of GHG, although China's per-capita emissions were only a small fraction of those from Canada and other wealthy nations.

In the world's 30 wealthiest nations that comprise the Organization for Economic Co-operation and Development, the growth in energy demand is projected by the IEA to slow abruptly, while CO_2 emissions will peak about 2015 and decline to 2004 levels by 2030. By that time, the European Union and Japan are expected to be emitting less energy-related CO_2 than in 2004.

Most of the projected increase in world energy demand will be for coal to generate electricity in developing countries. In these scenarios, oil will lose market share compared to other forms of energy, but oil demand will increase in absolute terms—from 84 million to more than 100 million barrels a day. In the case of natural gas, more means less—appreciably less CO_2 than burning oil, and much less than burning coal. World demand for natural gas is predicted by the IEA to grow 40 per cent by 2030.

Carbon capture and "clean" fossil fuels

Under even the more optimistic scenarios of both the UN's Intergovernmental Panel on Climate Change (IPCC) and the IEA, world population and energy demand will continue to grow for at least the first half of this century, albeit at a slower pace. Fossil fuels, particularly crude oil and natural gas, will continue to be the predominant energy sources, although their market share will shrink. Concentrations of planet-warming CO_2 will continue to increase.

The best hope of averting even higher levels of CO_2 in the atmosphere is widely seen in the emerging technology of carbon capture and storage (CCS), also known as carbon sequestration. Essentially this means capturing and compressing the CO_2 from production or use of fossil fuels, then storing it in underground geological formations or deep in oceans.

Including CCS in a portfolio of "other large-scale mitigation options such as nuclear power and renewable energy…could reduce the cost of stabilizing CO_2 concentrations by 30 per cent or more," according to the IPCC. It estimates that CCS could account for as much as half the CO_2 emission reductions achieved by mitgation efforts in the 21st century.[14] Claude Mandil, executive director of the IEA, says CCS is "one of the most promising tools in mitigating fossil-related greenhouse gas emission." He has urged governments to fast-track CCS regulations and encourage demonstration projects.[15] Natural Resources Canada describes CCS as "one of the few options available today that can offer the deep greenhouse gas reductions needed beyond those achieved through efficiency and fuel switching."[16]

Around the world, geological formations almost a kilometre or more below the surface are estimated to be capable of safely storing 16 billion tonnes of CO_2. Potential underground storage sites include deep salt-water formations, depleted or

ENHANCED OIL RECOVERY
Carbon dioxide from a coal gas plant is used to enhance oil recovery from the Weyburn field in Saskatchewan.
Credit: *Joey Podlubny*

mature oil and gas fields, and deep coal seams. Returning CO_2 to old oil and gas fields would be returning it to reservoirs where it had been trapped for millions of years. In some instances, this can increase petroleum production, helping to offset the cost. Injecting CO_2 into deep coal seams might greatly increase recovery of coalbed methane, which is natural gas trapped in the coal.

CCS and the Alberta oilsands

Worldwide, the big potential of CCS to curb global warming lies in capturing and storing carbon dioxide emissions from coal-fired electric power plants. These plants produce more than one-third of the world's total human-caused GHG emissions, the largest single source. Adding carbon capture to the design of a new power plant, or refitting an existing plant, is expected to cost about a billion dollars, resulting in higher electricity costs. This might be offset in whole or in part where the CO_2 can be used to recover more oil, natural gas, or coalbed methane, and, says the IPCC, from reduced health and environmental costs resulting from reduced emissions of sulphur dioxide, oxides of nitrogen, and particulate matter.

In Canada, CCS to reduce GHGs from oilsands emissions is likely to be as significant as reducing emissions from thermal power plants, and it could also lead to new low-emission or even emission-free fossil fuels.

Canada has been a leader in CCS technology. The world's largest CCS and enhanced-oil-recovery project has been underway in Saskatchewan's Weyburn field since 1998, where EnCana is pumping CO_2 into the oil reservoir at a rate of 5,000 tonnes a day, and expects to increase production from the field by 130 million barrels during a 25-year period. The CO_2 is supplied by pipeline from a plant in North Dakota that manufactures synthetic natural gas from coal. "The continued success of this project will have incredible implications for reducing CO_2 emissions throughout the world," says John Gale, director of the greenhouse gas research and development program with the IEA. In 2005, Apache Canada began injecting an additional 1,800 tonnes per day of CO_2 from the North Dakota coal gasification plant into Saskatchewan's Midale field, near Weyburn, where an additional 60 million barrels of oil production is expected. At Zama in northern Alberta, Apache has another project that injects hydrogen sulphide and carbon dioxide, recovered from sour natural gas production, into an oilfield to enhance oil recovery.

Canada's large coal-fired power plants are in Alberta, Saskatchewan, Ontario, and the Atlantic provinces. Due to its subsurface geology, Ontario has limited capacity to store CO_2, although it could possibly be shipped to depleted oilfields or deep coal seams in nearby U.S. regions—a reversal of the CO_2 piped from the United States into Canada for injection at Weyburn and Midale. The Ontario government, however, has said it will replace the province's coal-fired plants, and their CO_2 and pollution emissions, with nuclear power. As much as half the CO_2 from the power plants in the Atlantic provinces could be injected into coal seams, according to Natural Resources Canada.[17]

Canada's biggest and most immediate prospects for CCS are in Alberta and Saskatchewan where Natural Resources Canada says CO_2 from "the first clean coal demonstration facilities, equipped with CO_2 capture," as well as CO_2 from oilsands production, could be injected at rates of up to 10 millions tonnes per year by 2015. The practical CO_2 storage capacity of western Canada's oil and gas fields is estimated at close to five billion tonnes, with another two billion tonnes of

In Pembina, Canada's largest oilfield, it is thought that CO_2 might increase ultimate oil production by some 400 million barrels. Another pilot program is planned to see if CO_2 injection can boost production from the big Redwater oilfield.

storage capacity in deep coal seams, and about 100 times as much as this in aquifers. Potential storage capacity is not a limiting factor.

Bitumen and synthetic crude oil from the oilsands is Canada's fastest growing source of CO_2 emissions, and possibly the biggest challenge facing the petroleum industry. CO_2 emissions from bitumen and synthetic crude oil production accounted for about four per cent of Canada's man-made GHG emissions in 2005. Since output is expected to triple by 2015, that suggests the oilsands would then account for 12 per cent of Canada's anthropogenic GHG emissions, and the figure would be growing. But continuing efficiency improvement and new methods are almost certain to cut that. Much of these CO_2 emissions come from producing the steam that emulsifies bitumen too deeply buried to be strip mined, so it can be pumped to the surface.

One pilot test involves using solvents such as natural gas liquids, instead of steam, to separate the bitumen from the sand so that it can be pumped up. Another is a three-year "fireflood" test in which controlled combustion of about 10 per cent of the bitumen in a reservoir area cooks the rest into a less viscous state so that it can be pumped to the surface. As with injecting solvents in buried oilsands, this eliminates or reduces the need to burn natural gas to produce steam.

The feasibility of using geothermal energy to provide steam for in situ production is being researched by Suncor, Shell, Nexen, and the Alberta Energy Research Institute. The scheme, which might be in operation as early as 2012, involves pumping cold water down wells to hot rocks at least four kilometres deep and then recovering the steam as the water boils.

CCS, however, is considered to be the principal means by which emissions from oilsands production will be minimized. A CCS system envisioned by government and industry for Alberta's oilsands and coal-fired power plants is expected to cost in the order of $5 billion, including capturing and compressing the gas—the most expensive part—pipelining it to suitable sites, and injecting it. In anticipation of this, CO_2 is being injected in pilot tests at several oilfields. In Pembina, Canada's largest oilfield, it is thought that CO_2 might increase ultimate oil production by some 400 million barrels. Another pilot program is planned to see if CO_2 injection can boost production from the big Redwater oilfield.

Additional oil is not the only thing that might be recovered by CO_2. A pilot program to test CO_2 injection as a means to increase methane recovery from deep coal seams has been conducted by the Alberta Research Council since 1997 at a coal deposit within the Fenn-Big Valley area in central Alberta. An estimated 57 trillian cubic metres (200 trillion cubic feet) of methane—four times the amount of Canada's remaining discovered reserves of natural gas—lies trapped in the deep coal seams of the three western provinces. It is thought that CO_2 injection might double the amount of methane that could be produced, to as much as 90 per cent of the gas in place.[18]

Beyond enhanced recovery of oil and possibly coalbed methane, CCS is seen by Natural Resources Canada, the Alberta Energy Research Institute, and the Alberta Research Council as key to "low-emissions fossil fuels" and the likely source of hydrogen for a future hydrogen economy. They predict that "by 2015 to 2030, CCS will be increasingly deployed across the WCSB [Western Canada Sedimentary Basin], and it will have become an important facet in the design of new thermal electricity plants, refineries, oilsands upgraders [that convert bitumen into lighter synthetic crude oil] and any new or refurbished industrial facilities in the region." From this experience, Canada "could lead the world" in CSS technology.[19]

COAL
Coal is relatively cheap and abundant, but burning it produces large amounts of greenhouse gases.
Credit: *Oilweek*

Fossil fuels for the foreseeable future

"Fossil fuels can continue to play a significant role in the global energy system in this century, and probably long beyond." That is the assessment of environmental and energy professor Mark Jaccard, head of the School of Resources and Environment Management at Vancouver's Simon Fraser University, in a critically acclaimed book, *Sustainable Fossil Fuels: The Unusual Suspect in the Quest for Clean and Enduring Energy* (Cambridge University Press, 2005).

Current energy trends, asserts Jaccard, are unsustainable, in both ecological and human impacts. "To shift our energy system toward a sustained path, we need a clean and enduring combination of greater efficiency, nuclear [power], renewables, and zero-emission uses of fossil fuels." Renewable energy, he says, will "sustain a tremendous growth through this century," but will not replace fossil fuels.

By 2100, Jaccard foresees a 6-fold increase in the use of renewable energy, a 10-fold increase in nuclear power, and a 3-fold-increase in fossil fuels. The use of electricity would increase 6-fold to double its share of secondary energy, while hydrogen would zoom from zero to 30 per cent of secondary energy.*

In Jaccard's envisioned energy world of the 22nd century, fossil fuels would be almost completely interchangeable. Coal could supply synthetic natural gas, natural gas could supply liquid fuels, and all three fossil fuels could be transformed into almost any form of energy (heat, transportation, electricity, etc.), drawing on technology that already exists.

* Secondary energy is the amount of energy available after conversion into forms ready for use. The electricity coming out of a power plant is secondary energy, while the coal going into the plant is primary energy. Likewise, petroleum coming out of the ground represents primary energy, while the natural gas coming into our homes or the gasoline at a filling station are forms of secondary energy.

We would, for the most part, stop burning fossil fuels the way we do now, as gasoline or diesel fuel in motor vehicles, and for heating, cooking, hot water, and commercial and industrial uses. Instead, fossil fuels would largely be used to generate electricity, produce hydrogen for the hydrogen economy, and manufacture liquid fuels that rival biofuels in low levels of GHG emissions, fuels such as methanol from natural gas or other new synthetic fuels.

Jaccard believes that in most instances throughout this century, clean fossil fuels will cost less than renewable energy. The savings, he says, will enable "humanity to allocate more resources to social development goals of adequate and nutritious food, clean drinking water, quality housing, essential health services, education, security, and basic infrastructure."

OIL WORKER
An employee at Fairbank Oil works on an active well in Lambton County, Ontario. The Fairbank family has been producing oil for nearly 150 years. Credit: *Joey Podlubny*

EPILOGUE

A black llama shepherds a small flock of white sheep across a rough pasture near the southwest tip of Ontario. A small stand of ash and other hardwood trees fringe the pasture. A deep gully cuts through it. This is Black Creek, where early settlers noted black flecks floating down the stream, where Charles Nelson Tripp sought to turn bitumen into a paying asphalt paving business, and James Miller Williams dug his epochal oil well and cobbled together an oil still. Now, in late summer, Black Creek is dry, giving no hint of the swollen volume experienced after heavy spring rains.

The sheep pay no attention to the long strings of connected ash poles, as slender as a person's wrist, swinging back and forth on suspenders that hang from cedar fence-posts. These jerker rods on Charlie Fairbank's property, covering most of the Oil Springs field, continue to pump oil as they did when this 19th-century oilfield technology was developed on this same property by his great-grandfather, John Henry Fairbank. The rods activate walking beams at wells that have been pumping oil for 150 years, making this the world's oldest producing oilfield. Oil Springs gives proof of the industry's adage that the stone age did not end because the world ran out of stones, and the oil age will not end because the world runs out of oil.

Indeed, some 50,000 holes punched down to find and produce crude oil and natural gas in southern Ontario have yielded barely more than one-quarter of the oil and less than half the natural gas that the province's Ministry of Natural Resources expects might ultimately be produced. Little of that remaining oil and gas is on land; most of it lies under Lakes Erie, Huron, St. Clair, and Ontario. Drilling has been focused to date only on Lake Ontario.

Yet the scale of Ontario's oil and gas resources are not its most notable feature. The current rate of production amounts to barely one per cent of the province's annual oil needs, and two per cent of its natural gas needs. Rather, Ontario's petroleum legacy lies in the pioneer breakthroughs that helped set in motion the development of a global industry:

- North America's first registered petroleum company and first commercial oil well. Canada's first refinery, the world's first integrated oil company, and the associated technologies of the Canadian drilling system and the jerker line production method.
- Technologies such as the pole-tool Canadian drilling rig, the sliding "jars" over the drill bit, and the jerker line production method. (Canada can also claim some credit for initiating the research that led to methods for removing sulphur compounds from crude oil.)
- The "hard oilers" who came from Petrolia—more than from any other town in North America—who did so much to develop the early petroleum industry throughout the world, including western Canada.
- Canada's natural gas industry, founded by geologist Eugene Coste with the country's first large gas well in Essex County on the shores of Lake Erie in 1888.
- First experimental underground storage of natural gas by Union Gas Company in Welland County in 1915, and North America's first natural gas trading "hub" completed near Sarnia in 1982.
- The birth of Canada's petrochemical industry, and a major refining centre to this day.

In retrospect, it is also fascinating to consider that three of Canada's most historically significant oil discoveries—the original Ontario fields, Norman Wells in the Northwest Territories, and Leduc in Alberta—all tapped reservoirs in Devonian carbonate rocks.

To classify the 1858 well dug by James Miller Williams as simply North America's first commercial oil well is to vastly understate its significance. Miller, of course, did more than dig an oil well: he established the first successful oil producing, refining, and marketing business in North America, setting the stage for a sustained and integrated petroleum industry that would become the world's biggest business in the 20th century.

For a brief time in the 19th century, Canada ranked among the world leaders in oil production, but the American fields that came on the heels of Drake's 1859 discovery soon far outstripped Canadian production—at least until 21st century development of Canada's frontier and oilsands resources.

We might say that Oil Springs is where the industry got off the ground, while Titusville is where it started lifting into orbit. In that context, the real legacy of Ontario's early petroleum achievements is found in the global oil and gas industry that drives modern civilization today.

WHERE IT ALL BEGAN
Oil is still produced today from the field that Williams discovered in 1858.
Credit: *Robert Bott*

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Earle Gray, Lindsay, Ontario, June 2008

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